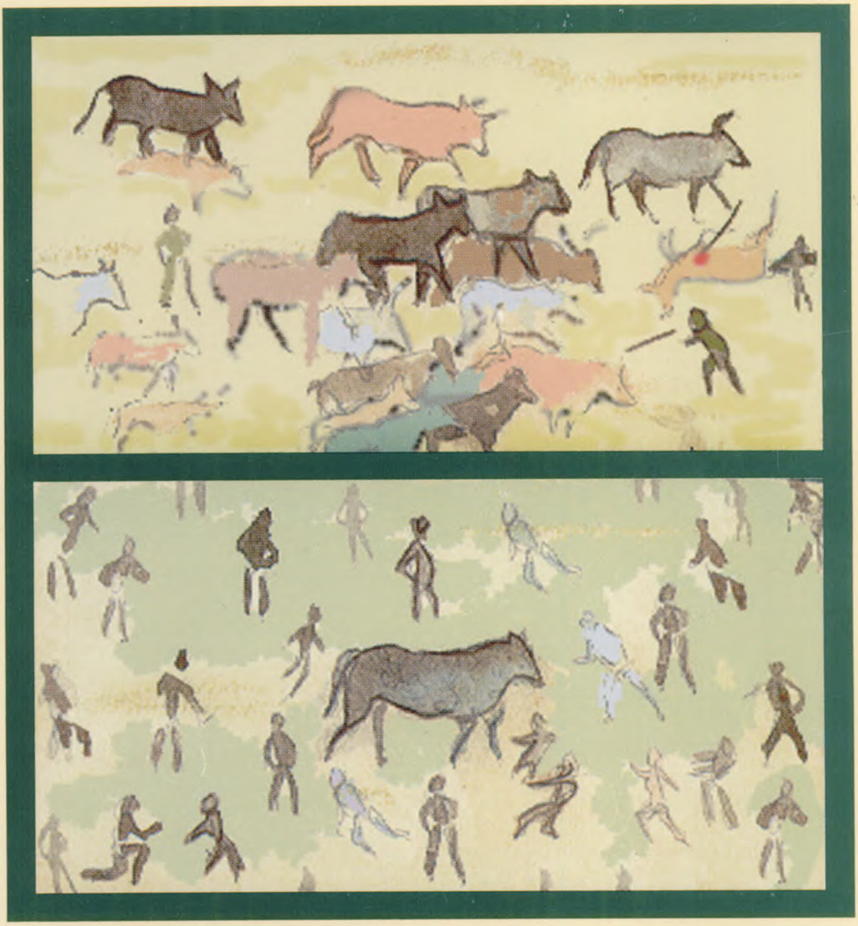
SOCIAL ANALYSIS IN FARMING SYSTEMS RESEARCH



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SOCIAL ANALYSIS IN FARMING SYSTEMS RESEARCH

Proceedings of the Second Workshop on
Methodological Aspects of Social Analysis
in Farming Systems Research

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FOREWORD

It is with great pleasure that this publication is made available to researchers, educators and technology transfer specialists interested in the development and implementation of technologies for resource-poor farmers, particularly those who use animals in their production systems.

This publication (originally published in Spanish in 1991) synthesizes the experiences and methodological proposals of a number of distinguished Peruvian researchers in different areas of the social sciences. In doing so, the Latin American Research Network for Animal Production Systems (RISPAL) and the Peruvian Center for Agricultural Studies and Development (CE&DAP) accomplish their objective of highlighting the desirability and importance of including the social sciences in any project or program intended to lead to an understanding of real production systems and to develop alternative technologies based not only on physical and biological resources, but also on the objectives, goals, and strategies of rural households, without losing sight of the socioeconomic and ecological setting.

Undoubtedly, systems research is a great advance over single-discipline and reductionist research. Nonetheless, until recently multidisciplinary work using the systems approach has excluded social scientists and, as a result, the appraisal of social, psychosocial, cultural, anthropological and economic phenomena has been incomplete and, at times, poorly focused. It is RISPAL's hope that both its pioneering effort in 1988 at the I Workshop on the role of the social sciences in agricultural systems research, and now this publication, a product of the II Workshop on methodological aspects of social analysis in farming systems research (coordinated by CE&DAP), will serve to spur and guide researchers' efforts to consolidate the systems approach, enriching the quantity and quality of the information required to generate fairer and more humane technology.

The Editors

METHODOLOGICAL ASPECTS OF SOCIAL ANALYSIS IN THE PRODUCTION SYSTEMS APPROACH

Benjamín Quijandría[1]

INTRODUCTION

In January 1988, the Latin American Research Network for Animal Production Systems (RISPAL) sponsored the First Workshop on the Application of Social Sciences in Production Systems Research in Chincha, Peru, followed by the publication of the pertinent proceedings in July 1989 (in Spanish) and in 1994 (in English). This meeting provided an opportunity for a group of researchers from the biological and social sciences to discuss the conceptual and applied aspects of social analysis in farming systems research. The conclusions reached at the meeting included the identification of certain methodological factors and specific contributions from the social sciences during the various stages and phases of farming systems research. In addition, the participants agreed that, at a later date, it would be necessary to study the application of specific methodologies for social and economic analysis as they pertain to the production systems approach.

On the basis of this decision, and with support from RISPAL, the Peruvian Center for Agricultural Studies and Development (CE&DAP) organized a Second Workshop devoted to the evaluation of social analytical methods and instruments in systems research. This meeting, entitled "Methodological Aspects of Social Analysis in Farming Systems Research," the proceedings of which were published in Spanish in 1991 and are here being presented in the English translation. The event was attended by technical staff and farmers engaged in the Guinea Pig Production Systems Project, part of whose field activities are being carried out in that same region of the country. The objectives of this meeting were as follows:

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1 Executive Director, CE&DAP. Coordinator of the Workshop "Methodological Aspects of Social Analysis in Farming Systems Research."

- To select methodological instruments for the analysis of psychosocial, sociocultural and economic phenomena as they pertain to production 'systems research.

- To prepare methodological guidelines applicable to ongoing production systems research projects, as well as recommendations and working strategies for individuals working in the social sciences.

- To test the selected instruments with actual farmers, to interpret the information and to extract conclusions relevant to the various processes involved in systems research.

- To prepare a publication containing the different methodological instruments tested, in order to show research teams their advantages.

Thirteen participants attended the meeting, five from the National Agricultural Research Institute-Cajamarca, plus eight researchers from Lima and Puno (see the list of participants in Annex 1). The group was multidisciplinary, including scientists in social psychology, sociology, economics, farming systems and biological sciences.

The Program consisted of three parts. During the first of these, the authors of papers on the methodologies used in the analysis of psychosocial, sociocultural and economic phenomena gave presentations on the conceptual and methodological bases used in selecting analytical tools. These presentations (included in the following chapters) were then discussed at length by the participants. During the second part, a field test of the analytical tools was carried out with selected farmers from the Guinea Pig Production Systems Project. Finally, during the third part the participating researchers presented a primary analysis of the farmers' main socioeconomic characteristics as they pertain to the Guinea Pig Systems Project, as well as their linkages with the methodological phases of the systems approach. This part of the meeting also generated a wide-ranging and interesting discussion involving all the participants.

This publication is the outcome of the papers presented, field experience and the subsequent discussions by the team of multidisciplinary experts who participated in the meeting. The contents have been assembled in such a way as to facilitate the reader's understanding of, and to underscore the need for, social studies in projects that may appear to be of a biological nature, but which adopt the production systems approach.

The next two chapters deal with general aspects of the need for social studies as a complement to production systems research work and previous experiences regarding the advantages and problems involved in their insertion into projects. In addition, the authors highlight some of the most important topics that require further analysis and suggest the type of information called for in order to strengthen different stages of the systems research approach.

The chapters by Ana María Montero, Víctor Agreda and Ricardo Claverias present the methodology for analysis of psychosocial, sociocultural and economic phenomena presented by the participants. This methodology was tested with a short field experiment during the course of the meeting. The sequence allows the reader to take in the various levels of analysis, ranging from the perception and understanding of farmers' underlying and/or unconscious ideas to the pinpointing of their visions, conceptual frameworks and production and reproduction strategies. In every case, the emphasis of the methodologies proposed is geared toward reaching an understanding of the phenomena involved in the adoption of technologies, economic evolution and campesino differentiation, all important components of the rural development process. In other words, the aim is to link the results of selected analyses of social considerations directly to productive phenomena that are of interest to researchers from the biological sciences.

The chapter by Benjamín Quijandría presents methodological procedures used by social scientists in the planning and conduction of research, under the production systems approach, indicating at which phases and stages they should be used. The last sections of the book include a list of the participants, brief sketches of the authors and editors of the English version and, as annexes, the survey forms and tables used in each area of analysis.

The CE&DAP, the Coordinator of the Second Workshop, the authors and the editors, wish to express their thanks to the technical and field staff and farmers participating in the Guinea Pig Production Systems Project for the strong support they provided. Furthermore, we should like to thank Ms. Aida Roca de Nadramia for her hospitality and help during the participants' stay at the Hostal Laguna Seca in Cajamarca, as well as Ms. Graciela Vertiz for her collaboration during the organization and execution of the meeting. Lastly, our thanks go to RISPAL's Coordinator and Board of Directors, and to IICA, for their promotion and support of the meeting. Special thanks are due to Ron Leaver for the English translation of this document, Laura Barboza for the typing and Martha E. Umaña for the layout.

SOCIAL SCIENCES AND PRODUCTION SYSTEMS

Benjamín Quijandría[1]

INTRODUCTION

In the context of technology generation and transfer and rural development, the production systems approach offers an alternative methodology to the traditional approach to agricultural development. For many years, there was a tendency to isolate and treat as subdivisions the different elements of production that come into play on family landholdings, endeavoring to promote their development through efforts targeted at specific crops and types of livestock or even, in a few cases, at mixed crop/livestock production units. This concept was best applied during the "Green Revolution," whereby international research centers and development agencies placed particular emphasis on genetically engineered plant improvement as a vehicle for development (Zandstra et al. 1981; Quijandría et al. 1988; Ruiz 1994b).

The traditional approach led to the development of enterprises devoted to the commercial exploitation of single crops or specialized livestock operations, with little or almost no impact on subsistence agriculture or small-scale farming. Historically speaking, the result of this approach has been not only the stagnation of small farmers but, in many cases and in many countries, a deterioration in their productive and economic conditions.

The so-called "crop systems" approach was developed by international and regional research centers and national institutions as an alternative to these methodological problems (Zandstra et al. 1981). The focus of this approach is on the actual conditions of subsistence agriculture in which different spatial and chronological arrangements of a number of crops are managed simultaneously. In subsequent years, livestock production systems research got under way, also with the aim of

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understanding the interrelationships between different livestock systems on family farms (Li Pun and Zandstra 1982; Quijandría 1986).

In what marked a second stage in the recognition of the importance of the campesino economy within production systems, economic analyses were then incorporated into systems research previously encompassing only biological considerations.

Over recent years this approach has evolved towards a holistic concept of production systems combining ecological, biological, economic and social considerations in order to study the farmer, the family, the productive unit and the resources employed (Shanner et al. 1982). It is here that the social and anthropological aspects of farm production are considered as an integral part of the study of the agricultural production process (Espinosa 1986). The production systems approach, therefore, focuses on: (1) the interdependence between the components of the household production unit, under the control and management of family members; and (2) the interaction between these components and the biological, physical and socioeconomic factors outside the family's control. When the production unit is considered as an integrated whole, it becomes possible to:

- Analyze the different facets of life in rural households and their geographical and ecological setting.

- Analyze, in time and space, the problems and opportunities that the household unit faces.

- Establish priorities in response to those problems and opportunities.

- Recognize the connection and correlation between the different subsystems of the household unit, and the corresponding linkages between household, community, microregional and regional systems.

- Evaluate the findings and impacts of research and development in terms of the production unit as a whole, and the interests of the farmer and the society to which he/she belongs (Dillon 1976; Hardwood 1979; Shanner et al. 1982).

Lastly, the production systems concept not only takes into consideration the work of the farmer at the farm or production unit level, but also analyzes and evaluates off-farm activities, including nonagricultural economic activities. This obliges researchers from the biological and social sciences to maintain close contacts with subsistence farmers and allows them to observe their situation firsthand and understand their aspirations and goals.

This redefinition of concepts makes it possible to understand the family, its productive resources and relationship to the production process. This chapter will address a number of the theoretical and methodological aspects of the production systems approach and how they relate to the family and its agricultural production unit. These elements provide the basis for social analyses thus contributing to a better understanding of the social and economic mechanisms and decision-making processes involved in household production systems.

CONCEPTUAL CONSIDERATIONS

Even though many authors have defined the conceptual aspects and basic elements of the systems approach, it is worth pointing out certain general definitions and concepts with a view of unifying criteria with respect to production systems and their relationship with the family, society, the production unit and the role of the social sciences.

Work on production systems can be defined as *a methodological approach that makes it possible to put some order in the way reality is perceived*. The systems approach makes it possible to define, in an orderly fashion, the components, interactions and limits of the production unit, enabling researchers first to analyze and then synthesize what they regard as the components and interactions of the production process. This can be done independently--from either the social, economic or biological standpoint--or can be superimposed on an interdisciplinary perspective in which all the components are described from the different perspectives of each field of science.

The systems approach is *a tool for synthesizing and analyzing the perceivable reality*. It makes it possible to adjust the elements of production and undertake technological interventions keyed to specific components, but without losing sight of the holistic nature of the production system, its insertion into larger systems, and the impact of changes on the system as a whole.

A production system can be defined as a *set of components that interact in a harmonious manner within defined limits, and generate final outputs proportional to the elements or exogenous inputs that play a role in the process.*

Similarly, the household production unit can be defined as *a system composed of the family and its productive resources, whose object is to guarantee the survival and social reproduction of its members.*

These definitions make it possible to superimpose the concepts of production systems and household production units, fusing holistic approaches in which the bioeconomic phenomenon of production is linked to the socioeconomic decision-making process, as developed by farmers and their families. These views provide the basis for the development of the methodological aspects in this chapter.

The main objective of systems analysis is to define the relationship between the structure and function of the system, since once this interrelationship is known, it becomes possible to design better and more efficient systems (Hart 1979). Other objectives include enhancing knowledge of systems and their components, understanding their functioning and the factors that impinge upon productivity. An isolated component of the system can only be described and analyzed in a limited way, so it should be studied in the context of the larger systems to which it belongs.

HIERARCHICAL LEVELS IN PRODUCTION SYSTEMS

Perhaps one of the most important concepts to be considered in the systems approach is the definition and understanding of the hierarchical levels between systems. On the basis of the concepts and definitions described in the previous section, the characterization of systems can be applied to different political, social, economic, biological or ecological processes. Household production systems normally form part of larger systems (campesino communities, for example), which by their very nature are hierarchically superior to the family unit. Similarly, the campesino community also belongs to a larger system such as a microregion, a watershed or an agroecological zone (Hart 1979).

Figure 1 illustrates the hierarchy between the household and the production systems containing it. As has already been pointed out, the analysis and study of components and interactions not only analyzes the internal and intrinsic aspects of the system, but also sets out to describe and understand exogenous elements and inputs external to the production process.

Viewed in this light, the definition of the hierarchical levels plays an important role in the study of the exogenous and endogenous factors--be they cultural, social, economic or bioproductive--that affect, limit or stimulate production systems (Quijandría et al. 1988).

The highest-ranking hierarchical level may include a microregion, watershed or larger agroecological zone. The components of this system include population centers, the production structure that exists in the area, privately owned and communal agricultural units and the transportation and communications infrastructure. It is at this level that regional economic influences are generated and the great cultural, social and economic structures that impact and modify the region's household production systems are defined (Hart 1988).

The study and analysis of the superior hierarchical system will make it possible to define the socioeconomic setting, as well as the constraints exogenous to the agricultural production systems. Such analyses are usually based on secondary information, with particular emphasis on those aspects which are most pertinent to, and influence, second-level hierarchical systems.

In the case of the Peruvian highlands, the campesino community (in most cases engaged in small-scale production) is the second-level system. The community system is composed of physical elements, such as communal pastures and crops, privately owned plots, and water sources, as well as social elements, such as community councils and the set of family interrelationships. Analysis of this hierarchical level makes it possible

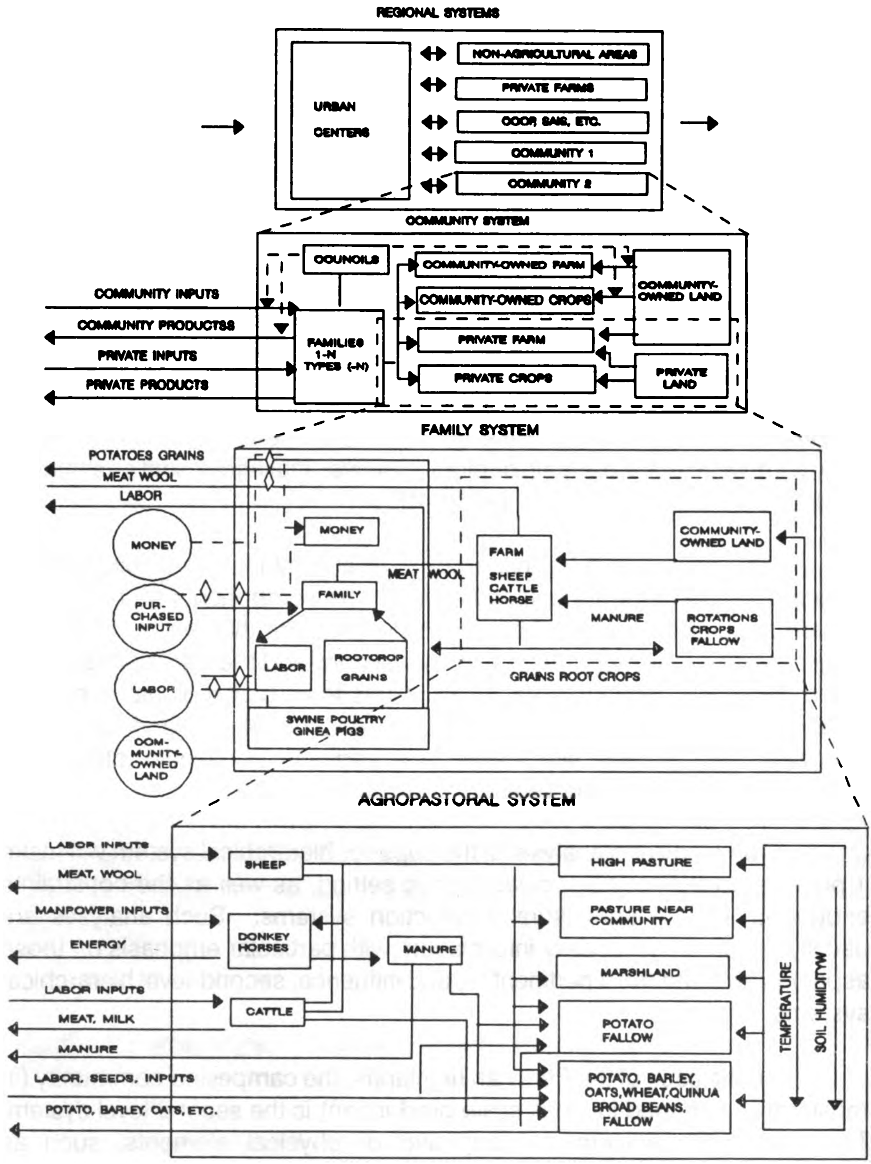

Fig. 1 The hierarchy of systems: An illustration

to define more clearly the immediate setting of the household production system, and identifies the endogenous elements that influence the production process and the economic capabilities of family units (Espinosa 1986).

The third hierarchical level is the household production system. Its components and interactions are the central focus of study and analysis under the holistic production systems approach. The components vary according to the agroecological location of the landholding, while production strategies or patterns reflect the socioeconomic characteristics of the community (second-level system) and of the microregion or watershed (largest or first-level system).

Understanding and ranking the different systems will facilitate the analysis and capacity to improve the production systems at the family level, and will provide the primary frame of reference for the studies undertaken by social scientists (see chapter by Ana María Montero).

THE SYSTEM AND THE PRODUCTION UNIT

Having defined the system as the element that encompasses the production unit, the farmer, and the family, this section will address the interactions involved.

The main components of the household production system are the farmer and the family, the soil, the land resources, crops and livestock. Many authors have dealt in depth with the descriptive aspects of the biological components of such systems, with special emphasis on crops and livestock (Zandstra et al. 1981; Perevolosky 1984; Li Pun and Gutiérrez-Alemán 1986; Quijandría 1986). However, very little has been written about the social aspect of production (Espinosa 1986; Ruiz 1994a). Producers, their families and their socioeconomic environment are acknowledged to be the key elements in the decision-making process regarding agricultural production. More detailed study of this aspect is called for in order to understand and become familiar with the so-called "campesino rationale."

Production and productivity are the result of decisions regarding the allocation of production resources, such as land and manpower, to different segments of the production process. This means that the phenomenon is not exclusively biological in nature; rather, biological considerations are subject to socioeconomic factors (Espinosa 1986; Agreda et al. 1988; Quijandría et al. 1988). From the social standpoint, the main factors to be weighed in the interaction between the production unit and the system include the knowledge and understanding of the socioeconomic mechanisms of family reproduction; the definition of the goals and aspirations of farmer and family; the definition of life plan and production strategies; and lastly, the ways in which these elements affect the decision-making processes related to agricultural production and productivity.

A household production unit is an integrated system, the objective of which is to guarantee family reproduction and survival. This means that producers, as far as their resources permit, will seek a conservative method of maintaining production minimums in order to guarantee (1) household consumption and (2) sufficient monetary resources to cover their production and household needs. These considerations determine the strategies used to minimize and avoid risks that are characteristic of small-scale agricultural production.

Farmers, true to their sociocultural context, have defined, often implicitly, the goals and aspirations for their households. In this context, use of their production resources will be geared toward those same family goals and aspirations. This process can lead to specific production strategies with objectives that are not directly related to the optimization or maximization of the production and productivity of crops or livestock, but rather are keyed to the farmer's overall requirements and needs for attaining his/her goals.

Family reproduction and the definition of goals and aspirations will have a direct impact on the structuring of the farmer's life plan and production strategies. These strategies, in turn, will influence or give shape to the main technological features and resource allocation of the production process. All this leads to the need to study and analyze the decision-making process of the small farmer. The recognition and understanding of the decision-making mechanisms will expedite the process of generating and transferring technology to the small farmer. Recognition of the stages involved in production decisions will facilitate an understanding of the so-called "campesino rationale."

In terms of the social environment of production, it is important to study and analyze the factors that determine the supply of manpower, such as family size and permanent (expulsion) or seasonal migratory strategies. The household migratory phenomenon will have an additional impact on informal education and training through experiences outside the household production unit.

Other social factors that determine household strategies include the age and level of formal education of farmers and their families; their primary and secondary occupations; the nuclear or extended structure of their families; the establishment and maintenance of family networks inside and outside the peasant community; and, lastly, their position within so-called reciprocity agreements within the community. All these phenomena take on a special dimension when the system immediately above them in the hierarchy is the campesino community. This setting will define and shape family and reciprocity relationships, in line with local social patterns.

The main interrelationship between the system and the production unit concerns the management and decision-making aspects of farmers and their families. For this reason, the holistic study of production systems has to be based on more than the knowledge of the biological segments, their dynamics and interaction. It is also necessary to understand the effects of the farmer's life plan, and production and family reproduction strategies, as well as the goals and objectives of farmers and their families. All of these factors will undoubtedly affect the system's technological profile and the possibilities of boosting production and productivity.

PROGRESS ACHIEVED BY, AND CONSTRAINTS UPON, STUDIES IN THE AREA OF THE SOCIAL SCIENCES

Our knowledge of Peruvian agriculture has been enriched over the past two decades by the substantial headway made in social and economic research. In the late 1970s, a specific sector of Peruvian agriculture was identified and since then has come to be known to as "the campesino economic sector."

The characterization, dynamics and most important aspects of the Peruvian campesino economic sector have been advanced by the studies carried out in the fields of land tenure (Caballero 1980, 1981; Hopkins 1981); macroeconomics (Caballero 1981; Hopkins 1981; Figueroa 1983), social and organizational considerations (Murra 1974; Golte 1980; Gonzales de Olarte

1983; Golte and Cadena 1983; Kervyn and Tapia 1984; Plaza 1986); and, specifically, campesino economics (Caballero 1981; Figueroa 1981, 1983; Gonzales de Olarte 1984; Pontoni 1984).

The main features of the campesino economy include efficient use of the meager resources available (Figueroa 1981; Kervyn and Tapia 1984); optimum use of the household work force; the development of risk-avoidance strategies, with the diversification of crops and livestock as one of its main characteristics (Figueroa 1981; Gonzales de Olarte 1984); high level of household consumption and barter (Figueroa 1981; Pontoni 1984); the quality of the agricultural holding as a unit of production and consumption (Figueroa 1981); the sale of organized labor, generally in campesino communities (Golte 1980; Figueroa 1981); the subordination of the campesino economy to the capitalist system (Caballero 1980); and, lastly, the realization that the main objective of the campesino economy is to guarantee the reproduction of the families of which it is composed (Caballero 1981; Figueroa 1981, 1983; Gonzales de Olarte 1984).

There have been many successful analyses and studies of the campesino economy. Nonetheless, in his assessment of such efforts, Gómez (1985) raises a number of questions and points out areas requiring attention. He suggests the need to examine the analytical unit of the campesino economy and to make typological studies of communities and farmers. He also proposes the need for a noncapitalistic economic appraisal and highlights the lack of theoretical models regarding the role of the state in the campesino economy and the need for a multidisciplinary approach.

It is clear that one of the most important ways of enhancing studies on campesino economics would be to integrate the biological sciences in order to broaden understanding of the socioproductive phenomena that affect this sector. Another issue on which there has been little conjecture or theorizing is the role played by livestock in the campesino economy. In order to gauge the interaction between crops and livestock, long-term studies analyzing the factors that interface and affect production in this sector are needed.

One of the main limitations of studies on campesino economics is the fact that they are based on empirical data from a few, isolated studies scattered throughout the highlands. In this connection, there is quite clearly a need for methodologies that make it possible to develop typologies of producers with a view to identifying common factors affecting the campesino economy as a whole.

The production systems approach can rediscover factors that explain productive, economic and social behavior at the individual, household and social setting levels. Thus it would be possible to plug some of the gaps in earlier campesino economics research by studying the internal and external factors that affect the household and its production unit and by recognizing the existence of strong interactions among the different components.

In Peru over the past five years, research projects using the production systems approach have begun to systematically incorporate studies and analyses from the social sciences. (Perevolotsky 1984; Espinosa and Rojas 1985; Diaz et al. 1985; Valer 1985; Espinosa 1986; Agreda et al. 1988; Quijandría et al. 1988, 1990; Quijandría 1989, 1994; CE&DAP 1990a, 1990b). As a result of this interest and the usefulness of socioeconomic studies and analyses, RISPAL published the results of a seminar which examined the role of the social sciences in systems research (Nolte and Ruiz 1989). The English translation of this document was published in 1994 (Ruiz 1994a).

The following chapter presents a detailed analysis of the experience obtained in incorporating sociological studies into a project that was executed adopting the production systems approach. In addition, specific recommendations are made on topics and areas in which further study is required, particularly where Andean production systems are concerned.

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EXPERIENCES IN THE INTEGRATION OF THE SOCIAL SCIENCES IN AGRICULTURAL SYSTEMS RESEARCH

María Cristina Espinosa[1]

INTRODUCTION

In 1983, the Small Ruminant Collaborative Research Support Program (SR-CRSP), under an INIPA-University of California at Davis Agreement, initiated the Project for Technological Validation in Campesino Communities in Peru, adopting the production systems approach. In view of the complexity of Andean production systems, a social analysis group was created to strengthen the diagnostic and analytical capability required for this endeavor.

The first task of the group was to facilitate the inclusion of the sociology component into production systems research in order to enrich both this approach and the sociological discipline as such (Quijandría et al. 1984).

An initial step was the establishment of a conceptual framework that would integrate, coordinate and interface sociological research with the other disciplines engaged in the project and in the systems approach, in order to avoid isolation and expedite communications and the interdisciplinary exchange of ideas. Such a conceptual framework made it possible to plan the next steps in the process.

Sociology in particular, and the social sciences in general, were seen in a negative manner, and this image needed to be overcome. This image was created both by preconceptions and research techniques ill-

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suited to gaining an understanding of the country's agricultural systems. As a result, interdisciplinary discussion of agricultural and rural development was affected.

The representatives of the biological and exact sciences, able as they were to quantify outputs in terms of yields, efficiency indexes, bio-productive parameters, and so on, were hoping for rapid feedback from the social sciences, particularly with regard to those social aspects that they either did not understand or could not manage, and which they perceived as obstacles to the adoption of new technologies by farmers. At the same time, and somewhat contradictorily, the role of sociology was perceived as being limited to research and promotion in fields such as education, training and the family.

In January 1985, a global conceptual framework was presented at the Meeting of Senior SR-CRSP Researchers in Lima, details of which are provided below.

The scope of the SR-CRSP included goat production systems along the northern coast, sheep and alpaca grazing systems in Puno and mixed Andean systems in Junin and Cusco. The latter were notable for their complex spacial-temporal arrangement of crops and livestock and for the social organization of their production activities. This complexity made it necessary to clarify and define a methodology for identifying systems according to the characteristics and social conditions of the regions. This decision acknowledged the fact that the methodology thus developed might not be applicable to other settings and less complex production systems, although it would have broad applications for production systems in Andean regions.

CONCEPTUAL FRAMEWORK

The basic premise for defining the conceptual framework was that production is a social phenomenon par excellence involving a series of social relationships and interactions among individuals, as such or through objects; between man and nature; and between persons, families and institutions at a number of levels.

Production does not take place in a vacuum, but is an integral part of the social fabric that is determined by environmental, socioeconomic and cultural factors. This, in turn, means that a social determinant is involved when decisions are made about the use and allocation of resources, access to the means of production, access to and the use of technology, and the destination of products (whether market-oriented or for household consumption). These decisions are based on such factors as the availability of capital, comparative advantages, traditions, and cultural background.

In the small-scale production sector or campesino economy, production is part of a survival strategy, and also part of the reproductive cycle of the campesino family. This process has three facets:

1. Material reproduction (daily reproduction of the family labor force and material reproduction of the system's resources)

2. Biological reproduction (marriage, fertility, childcare)

3. Social reproduction (socialization of children; legacy of moral standards, roles, values and knowledge; and the maintaining of social relationships that are basic to the system, such as kinship and reciprocal agreements in the community).

This fact is the key to understanding that campesinos incline toward the production of, say, alpacas or corn because, first and foremost, it would assure the subsistence of their families. There is thus a radical difference between campesino production systems and commercial agricultural enterprises, the aim of the latter being maximum profitability and gain.

Farmers' goals are harmonious with conditions they are inmersed in: environment, resources and means of production, socioeconomic structure, and so on. This leads to a productive behavior that calls for a complex decision-making process--that is, production decisions must consider relationships within the inmediate family, the extended family and the community, insofar as these sectors affect the access to, and the allocation of, production resources (Fig. 1).

Most studies tend to focus exclusively on production outputs (those of a measurable, tangible and "objective" nature), bypassing the analysis and understanding of productive behavior. Like all human behavior, this is difficult to address and measure. However, in order to understand the logic of a given production system, the underlying productive behavior must be identified and understood.

Productive events and outputs generate income, capital and employment which will influence farmers' goals and their objective conditions. The latter, in turn, will affect the productive events and outputs. The farmer has many ways or means of obtaining cash, either as a migrant laborer, as a sharecropper, or by undertaking side activities, such as handicrafts, trade, or product transformation. Thus, there is a need to understand productive behavior, as this is the dynamic factor whereby individual, familial and community strategies are all intertwined.

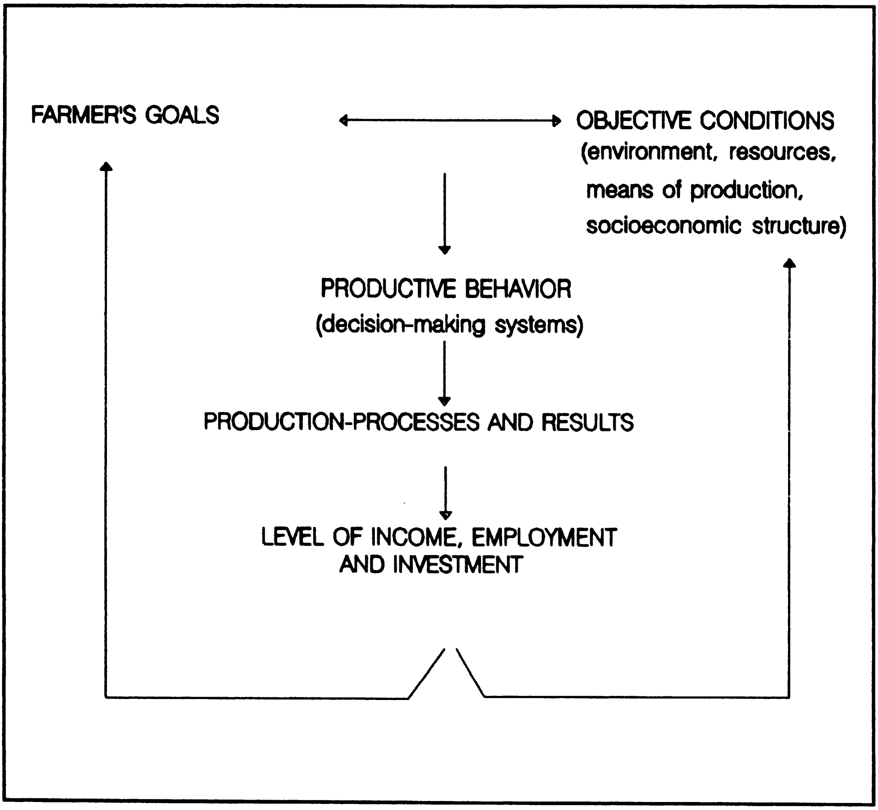

Fig. 1 Conceptual framework of the productive behavior of campesino families.

Social research on production systems must redefine conceptual tools in order to be able to understand and interpret specific phenomena at the microsocial level. This research must answer certain key questions:

- How does the small-scale production system operate as part of a socioeconomic system?

- How can certain patterns of productive behavior and the decision-making system be explained?

- How can the production system be improved?

- How can maximum receptivity to new interventions be achieved?

- Does this model reflect the farmers' goals and their familial and community organization?

The complexity of production systems in the Andean setting makes it difficult to understand their diachronic functioning and the global strategy of small-scale farmers. Thus, a conceptual framework for mixed Andean systems was developed (Espinosa 1985).

As can be seen from Figs. 2 and 3, there is a great deal of interaction between the family, agriculture and livestock, through flows of labor and resources which feed one another. This model transcends the function traditionally assigned to the crop-livestock interaction: the use of crop residues for the feeding of animals, which in turn provide manure for crops. In fact, animals can be used as a source of power for plowing and transporting the harvest, thus contributing inputs for cropping, as well as income to help the farmer face any economic contingencies that may arise. Livestock also is a money-saving mechanism. In addition, livestock generates products for sale or household consumption and optimizes the use of surplus family labor (women and children).

The salient features of these mixed production systems are listed below and must be taken into account when defining the scope of action of future technology transfers.

- Family reproduction in mixed systems is based on agriculture, livestock and the occupational diversification of the household.

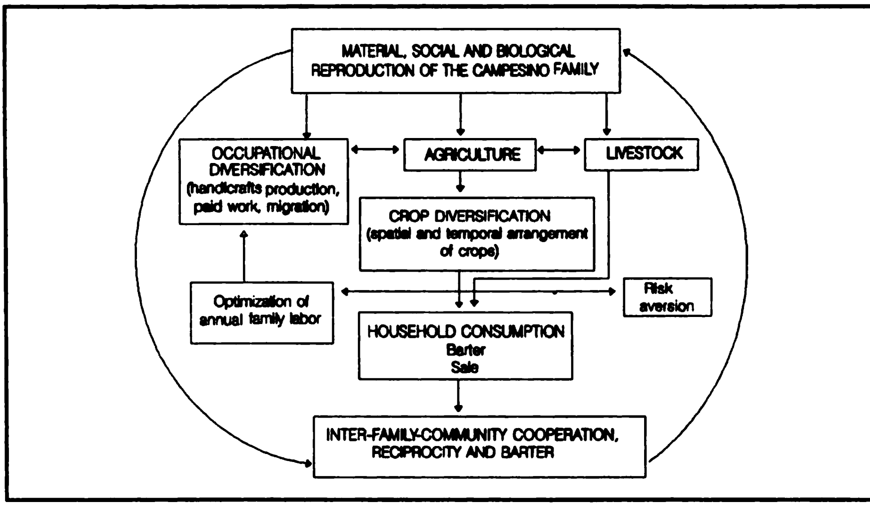

Fig. 2 The household production system.

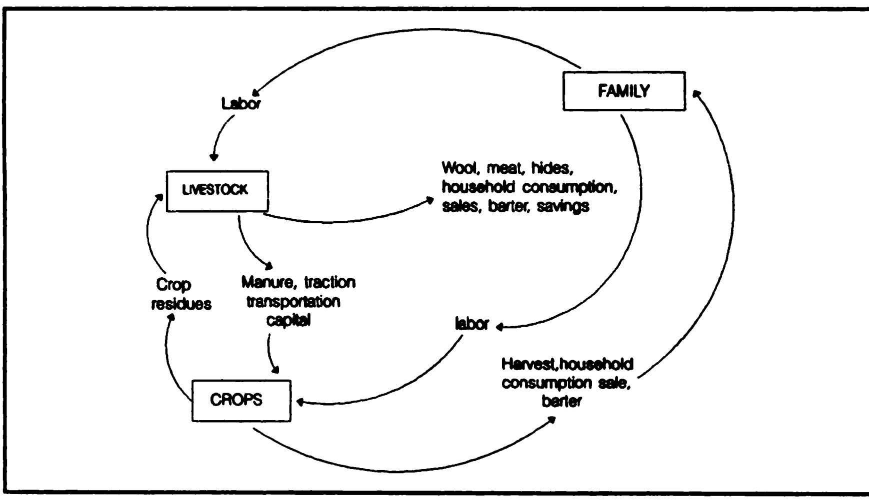

Fig. 3 Flows of agriculture-livestock interactions.

- Risk aversion (climatic, pests and market) and optimization of family labor are always taken into account in the management of agricultural cycles.

- Reciprocity, barter relationships and community organization are key factors affecting access to resources such as labor, arable land and pasture.

- The farmer's stock of empirical knowledge must be taken into account in any technical evaluation of these systems.

- Often it is not the lack of expertise that stalls a system, but the economic inviability of putting it into practice.

- Family, inter-family networks and the community organization interactions affect the functioning of the systems in terms of relationships, reciprocity, solidarity and conflict-solving.

The following is a list of the most important constraints to production systems:

Constraints	**Consequences**
high dependence on climate	the productive strategy must be evaluated against risk
poor insertion into the consumption vs. sales	low pricing of products/high production costs
scarce, poor-quality land	low productivity
scarce and poor pastures	seasonal and off-community grazing
improvements limited by cash	traditional management
poor animal and plant health practices	traditional practices
high family reproduction costs	occupational diversification, migration of members, decrease in consumption

CHARACTERIZATION OF SYSTEMS

The discussion of the conceptual framework and familiarization with the technical and productive aspects of the SR-CRSP program made it possible to participate in, and contribute to, interdisciplinary meetings that set out to characterize production systems in different agroecological settings. The complexity of campesino life in Peru called for the identification of the hierarchy between systems and subsystems.

Based on a number of criteria, the production systems present in each homogenous zone were identified and classified into different strata. This method was an improvement over the traditional campesino stratification based only on information regarding the land resource or herd size (Quijandría et al. 1988). This process took account of both access to resources and the type of agriculture; it also took account of the proportion of family labor used (both reciprocal and paid) and the relative importance of livestock and extra-agricultural activities, whether commercial (trucking, milling, trade), salaried or artisanal. In the case of livestock systems, herd size and species were considered together with any complementary activities carried out, such as paid work, commercial activities, and occasional crop production. This methodology has made it possible to overcome overly unilateral and schematic approximations by identifying the differences that exist between campesino strata (Agreda et al. 1988; Quijandría et al. 1990). Thus, it has been an important contribution to the study of the so-called campesino economy.

In effect, when economists and sociologists classify campesinos as average, poor (or semi-proletarian), or rich, they generally do so on the basis of farm size, without referring to other features of their activity or their economic-productive behavior. For example, they fail to take account of the fact that livestock play a key role in mixed production systems. They also overlook the fact that different production strategies come into play. They even assume a degree of determinism in access to resources, without realizing the dynamism and complexity present in the rural setting.

From the systems approach standpoint, these results contribute to the enrichment of the characterization methodology which was too general for complex situations such as those in Peru. It was possible to confirm that, in a given agroecological zone, factors such as proximity to markets, historical factors that determined less social access to land and irrigation, and the importance of community organization and assets could explain why the production systems of two neighboring campesino communities were quite different. In addition, if the existence of strata within systems is not taken into account, research findings and technology transfer processes are distorted.

The SR-CRSP Sociology Unit also participated in the design, monitoring and analysis of the Dynamic Follow-up Survey used to characterize these systems. The survey, given the dearth of information at this level, was a priority task. This dynamic survey covered four regional settings: the northern coast (in the sparsely populated areas of Piura and Lambayeque) with goat production systems; the central highlands with mixed production systems (in communities along the intermediate altitudinal levels of the Mantaro Valley); and in the southern mountain range with mixed systems (in communities along the intermediate altitudinal level in Cusco), and livestock systems (in the Puno highlands).

At the same time, a diagnostic methodology was developed to identify the main ecological, economic, productive and sociocultural elements in the systems of each region. Although this methodology was discussed with the field teams (mainly with the leader and social scientist of each team), it was not assimilated and was subject to a number of constraints, of which the most important were:

- Inadequate understanding of the systems approach and of the problem to be solved. Reluctance on the part of social scientists to take up production as the main drive around which social interrelations and day-to-day activities occur.

- Tendency to collect too much information while failing to take account of the basic features of the problem to be characterized.

- Lack of a solid theoretical framework that aids in the rationalization of isolated data, detection of trends, identification of interactions, ranking of problems according their importance, etc.

After a number of changes in the teams, an alternative method was adopted: the characterization process was carried out at meetings where the information collected by the field teams was analyzed in response to questions and hypotheses which were continually being restated and defined. This method proved successful and made it possible to determine the context, identify the strata in the systems and select the sample for the dynamic follow-up. Subsequent statistical analysis of the information (Agreda et al. 1988; Quijandría et al. 1990) confirmed that the identification and characterization of the subsystems were correct.

By its very nature, the dynamic follow-up survey was intended to determine, record and evaluate the complex technical-productive management of the systems and subsystems concerned. The social component was limited to basic social parameters because of the high cost involved and the composition of the field teams. The analysis of these parameters and their interaction with the main production variables has been presented by Espinosa (1985, 1986), Quijandría et al. (1988) and CE&DAP (1990a, 1990b).

BASIC STUDIES

Further knowledge of productive behavior and the socioeconomic conditioning factors involved was obtained through a study of production strategies and family labor organization conducted in Cusco between 1985 and 1986 (Espinosa and Agreda 1986). This study combined a static survey of 30 producers with an in-depth study of three cases, including their life histories and family labor organization. The aim of the study was to determine common production strategies and the socioeconomic determinants of productivity.

All the families studied were similar in terms of land resources, the size of the on-farm family and the ages of the parents. Other common factors were access to three altitudinal levels and crop diversification. The use of technological innovations such as pesticides and chemical fertilizers was limited to irrigated plots (thereby reducing the risks involved) and to commercial crops. The use of yoked oxen and organic fertilizer was another common denominator.

Access to irrigated plots, together with herd size and market orientation, were factors that differentiated production strata and yields. Greater access to irrigated plots made it possible to develop a more market-oriented agriculture, in which livestock played a key role. Ownership of one or more teams of yoked oxen facilitated not only better preparation of the soil, but also the use of organic fertilizer and some degree of periodic liquidity (at the end of the crop year the oxen were sold for and replaced by a bullock, leaving a profit). Basically, ownership of oxen meant greater access to reciprocal labor, in exchange for the use of the oxen on more advantageous terms.

Given the shortages in family labor and the infrequent use of hired workers, access to reciprocal labor is a decisive factor not only in extending the limits of the production process and ensuring its completion, but also in achieving higher productivity. The families with the highest labor productivity and yields per hectare were those which made greater use of reciprocal work in proportion to family labor. This highlights the need for further study of reciprocity and kinship networks and their impact on production strategies.

One important finding of the study was that, while greater access to irrigated land can lead to higher yields, such results are not automatic. Generally speaking, it was possible to separate productive strata on the basis of the level of resources and market orientation; however, there were notable differences in yields within these same strata. This suggests that achieving higher productivity is not a question of determinism, though there are limits to the amount by which total income can be increased, limits that are determined by the size of both the resources available and the production process.

Access to resources was gained through a variety of mechanisms, thus implying flexibility in their allocation. The majority of plots were stated to be privately owned and had been inherited. Marriage is an important factor in inheritances, inasmuch as roughly one-third of the assets of the systems with the greatest resources had been inherited by women. Participation in communal work, and in community organization in general, permitted access to between 15% and 30% of the plots said to be privately owned.

While the leasing of plots was not usual, a type of "sharecropping," whereby families share use of the land, management, production and the harvest, was a common practice. This mode of farming was found among families from different productive strata. As well as contributing to higher incomes and profits, this farming system also permitted access to seeds and the use of land that would otherwise lie fallow because of a lack of resources; additionally, it provided labor and strengthened reciprocal ties between families from different systems.

With regard to the use of technology, it was found that differences in yields were due not so much to different technologies, but to the intensity of use of a single technological practice (for example, the level of chemical fertilizers or pesticides employed, or the seeding rate). This suggests that the limiting factor as far as technological innovations are concerned is not so much ignorance of such methods but the difficulty in meeting their cost. The reasons are twofold: cash liquidity and the uncertainty of a good harvest.

The in-depth case studies and life histories confirmed the dynamism involved in production strategies and in access to resources. There were cases of producers who were initially at a disadvantage, but were able to equal or surpass other farmers who started out with greater resources inherited from their parents or allocated to them when they married.

The migration of farmers to places such as the Valle de La Convención and Lares equipped them with production skills and increased the pool of resources available to the community. The constant search for ways of improving the situation has led to job diversification, supported by considerable inputs of family labor, a common characteristic of all systems and strata. The inability of families to satisfy their needs for land, labor and products for barter validates the need for community organization and reciprocity networks, both of which allow families to carry on the production process. This cannot be regarded as a simple economic process; it involves the entire family organization, reciprocity networks and community organization, including campesino and livestock migration which occurs outside the community on a seasonal basis.

Family size and farmers' age were relatively uniform; however, access to formal education was variable. In the poorest systems farmers tended to be illiterate and with a limited amount of primary school education, while a higher percentage of the members of the better-financed systems completed their elementary education.

In a setting in which no rural secondary education is available and the dropout rate is high, completing primary school is a comparative advantage. While it was not possible to gauge the impact of schooling on the adoption of technologies, it is reasonable to assume that the higher the level of education, the greater the ability to accept and handle them. Undoubtedly, the impact is clear when farmers aspire to community posts, must deal with the bureaucracy or engage in commerce (since formal education allows individuals whose native language is Quechua to communicate more fluently in Spanish).

Women perform a key role in the organization and designation of the domestic and productive roles of family members. They also have a direct participation in the production process and the tasks that permit the reproduction of the family labor force at the day-to-day and generational levels. Indeed, women control many aspects of farm life, such as distribution of the harvest, decisions regarding expenditure or investments and types of crops planted, as well as all aspects of the administration of household resources.

The departure of members of the family unit reflects an *ex post* adjustment of family size in terms of the objective of having all able family members occupied, according to the amount of resources available, although expectations regarding the future of the children is also a driving factor. The woman's opinion carries great weight in this process. They abhor the idea of seeing their children endure life as campesinos the way they have. This raises a series of questions as to the continuity of a campesino identity transmitted to the new generations, and the need to improve conditions if this identity is to be strengthened.

AREAS REQUIRING FURTHER STUDY IN SOCIAL RESEARCH

The Cusco study underscored the importance of understanding the reciprocity labor networks as a strategy aimed at guaranteeing the success of the production process. The study also showed the need for further study of the role of women and the campesino family in terms of their productive-domestic contribution and their participation in the decision-making process.

The work of campesino women in agriculture, livestock and other activities is generally underestimated and little is known of the role they play in decisions regarding production in the broadest sense. This lack of knowledge has implications for extension work and agricultural development, which are geared exclusively toward men. The research and technology transfer process, including systems research, does not take account of the active role played by women. Obviously, this situation may be affecting the adoption of technological innovations because of conflicts with activities under the responsibility of women or with the way the family workload is distributed.

Empirical evidence suggests that campesino women play an active part in the production process. In agricultural work, they perform tasks based on a division of labor by sex and age, which, in turn, varies according to the type of family involved and the type of resources at the disposal of the household unit. The absence of the male figure due to desertion, off-farm employment or emigration will result in the woman devoting more of her time to production activities and will determine the nature of the work, including tasks traditionally regarded as the preserve of the male: those which call for the use of tools or greater physical strength. As far as livestock is concerned, the woman will not only be responsible for taking care of domestic animals but also for shepherding, except in systems in which this requires travelling some distance or when livestock is divided according to gender. Women's participation in handicrafts and small-scale commercial activities is widespread, although the particular form that their involvement takes varies according to the importance of such activities and the way in which the family participates in them.

In campesino families no clear distinction is drawn between the domestic and productive spheres, nor between private and public activities. On the one hand, it is clear that the purpose of some activities regarded as everyday domestic chores (such as cooking for agricultural day laborers on small farms, helping other women or families in the kitchen or with other work) is to ensure that there is sufficient labor for production and to strengthen basic ties of reciprocity which is vital for achieving profitability and the socioeconomic reproduction of the farming system. Production is a phenomenon that transcends the family domain and purely economic considerations, and here the role of women includes work, organization, cohesiveness and decision-making.

In their role as administrators of their families' resources, and being familiar with their food needs, it is campesino women who decide what proportion of the harvest can be sold or needs to be set aside. They also have a say in what crops are to be planted. Women administer the money, so their consent is required in any decisions regarding expenditure and production investments. This control and decision-making power is manifest only inside the family, of which the man is the representative and spokesman. Such duality between formal subordination and the interdependence and complementarity underlying their decision-making power has, in the past, clouded researchers' understanding of the role of campesino women. Because of Western biases regarding relationships between couples, both traditional concepts guiding norms of behavior for women and the objective bases justifying their interactions have been overlooked.

The complex nature of the production process and the social web at the immediate and extended family and community levels, as well as the well-defined family organization that this calls for, can only be dealt with through consensus, complementarity and interdependence. Understanding this fact will improve the orientation of systems research, not only in terms of more precise characterization, but even in component-specific research geared toward innovations and changes to the system. Efforts to strengthen campesino undertakings should actively incorporate campesino couples, the operational core of these systems.

The social sciences must not only provide a framework that interprets this phenomenon, but also record and gauge it for different settings or contexts, thus equipping researchers from the biological sciences with specific tools for managing the problem.

The issues surrounding campesino women and families should be looked at from three different angles:

1. Their participation in the division of labor within each activity of the system

2. Their contribution to the generation of cash income and the reproduction of the family labor force

3. Their participation in decisions involving production, distribution and consumption and in issues affecting the family

A quantitative record of the division of labor is needed. This would make it possible to calculate the family members' contributions to cash and non-cash income (i.e., values supporting the reproduction of the labor force), and gauge their role in decision-making, establishing the points at which the control exercized is complete, shared or restricted.

There is also a need for greater knowledge of reciprocity networks, given their impact on production and campesino family life. It has been shown that campesino production is a process that transcends the sphere of the immediate family, inasmuch as it is impossible to carry out without the reciprocity networks which provide access to resources such as land, labor and other means of production. The impact that the community organization, the extended family and reciprocity networks have on production and family reproduction must be clarified and evaluated in different contexts and rural strata (in terms of both crops and livestock production activities) because such factors have specific implications for agricultural extension. For example, alpaca production systems include having herds graze on communal hillsides or *bofedales* (marshes) shared by the extended family.

An issue that has so far received little attention, but which is of vital importance to the agricultural development of the country and the projects involved in it, is that of the new campesino generations: What are the chances that these young people will follow their parents' campesino lifestyle? What are their and their parents' expectations for the future? What role does formal education play in this process and how can it be adapted to consolidate their campesino lifestyle? On-farm research and extension projects should incorporate young people as future producers, just as they should include women as producers and co-managers. This, in turn, calls for the generation of pertinent information to expedite their incorporation and make it germane and effective.

Another aspect requiring further study is the process by which campesino families regulate their size, as well as the factors determining the supply of family labor. The fact that rural overpopulation is channeled toward the cities through massive, sustained migratory flows would seem to suggest to those engaged in agricultural development projects that there is no shortage in the family labor force, but this is not the case. The family regulates its size *a posteriori*, maintaining only those members that it is able to provide for and who can be used effectively throughout the farming year. The rest are excised through migration to cities where they find work, and perhaps, study. Clearly the size of the resident family will depend on the type and amount of resources the family has at its disposal and the efficiency with which they are used.

The family limits its resident members to the minimum number for whom full, stable employment can be provided throughout the year. Any shortages that occur during the periods when the need for labor is greatest will be covered by reciprocal labor and, to a lesser extent, by the hiring of day laborers. In this connection, any technological innovation that substantially increases the demand for family labor will be very difficult to implement in the short term since it upsets the balance between the costs of reproduction and the comparative advantage of the members of campesino households.

What must be established are the factors that affect this regulation of the resident family in different campesino production systems, strata and contexts. What alternative mechanisms can propitiate full employment and the retention of all members of campesino families? What comparative advantages have technological innovations requiring a larger family labor force, as against the higher costs of family reproduction? Research on the mechanisms that regulate both family size and the size of the resident family, including the overriding objectives and the subjective conditioning factors (expectations, beliefs, etc.), will facilitate dealing, in operational terms, with the labor force variable as a limiting factor of production systems.

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METHODOLOGY FOR THE ANALYSIS OF PSYCHOSOCIAL PHENOMENA

Ana María Montero[1]

INTRODUCTION

The social sciences should be incorporated into the planning and execution stages of projects and programs that apply the production systems approach to agricultural production in research, technology transfer and rural development. In particular, social psychology can help in gaining an understanding of the behavior, motivations, values and strategies of farmers as individuals.

Technological breakthroughs and changes generated by projects and transferred to producers should reflect the perceived and real needs of the producer--needs which are sometimes misinterpreted and are not always the same as those felt by the researchers, project administrators, the State or funding agencies.

Production systems vary a great deal: even in areas that are geographically close to one another there may be many different types of production and differences in production opportunities. This heterogeneity has a bearing on the decision-making mechanisms at the family and community levels as well as in the local and regional intercommunal networks and in development projects supporting production and technology transfer.

Some components of the production system can be altered or modified by the actions of research or development projects and programs: soil use, the division of labor, input use levels, the destination of production (sale, household consumption, barter), investment rates, quality of products, and so on. These changes are influenced by the different mechanisms and levels inherent in the decision-making process.

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An important factor in the development of agricultural technologies is the design of a planned methodological strategy for analyzing the producer's basic life objectives which reflect his/her real, albeit at times subconscious, needs. This can be achieved by following the different stages of the systems approach to agricultural research, which may encompass various social analysis methodologies. This chapter offers a discussion of methods of psychosocial analysis as they apply to the agricultural sector (Fig. 1).

CONCEPTUAL CONSIDERATIONS

While it is true that the social sciences do not offer tangible outputs such as crop varieties or breeds of domestic animals, they do contribute operational concepts, methods, techniques and verifiable criteria for evaluating the degree of control and socioeconomic adaptation of the producer in terms of health, nutrition and diet, and environmental quality, all of which can be taken as indicators of both survival and quality of life.

There are many important factors to be considered in the systems approach, but some of the most basic are the producers' physical, psychological and social well-being. Research in the health field is well established and follows standard methods, but hitherto no procedures have been designed that will include factors inherent to the farmers' mental health that would make it possible to pinpoint their perceived and real needs or, in other words, that would give a comprehensive vision of their aspirations, goals and levels of well-being.

One effective technique is the case study methodology, using appropriate psychosocial instruments (based on depositions made by the farmers) that will allow the rationalization of their experiences in terms of their well-being and struggle for survival. If the producer's "cosmic vision"--relating total health to production--is identified and understood, he/she will gain greater self-credibility and will be more confident about planning and executing their activities and judging the cost/benefit relations when technological changes are proposed. In addition, this would make it possible to reduce the risks inherent in the agricultural production system because farmers would possess a critical awareness of their capabilities, weaknesses, options and transfer proposals

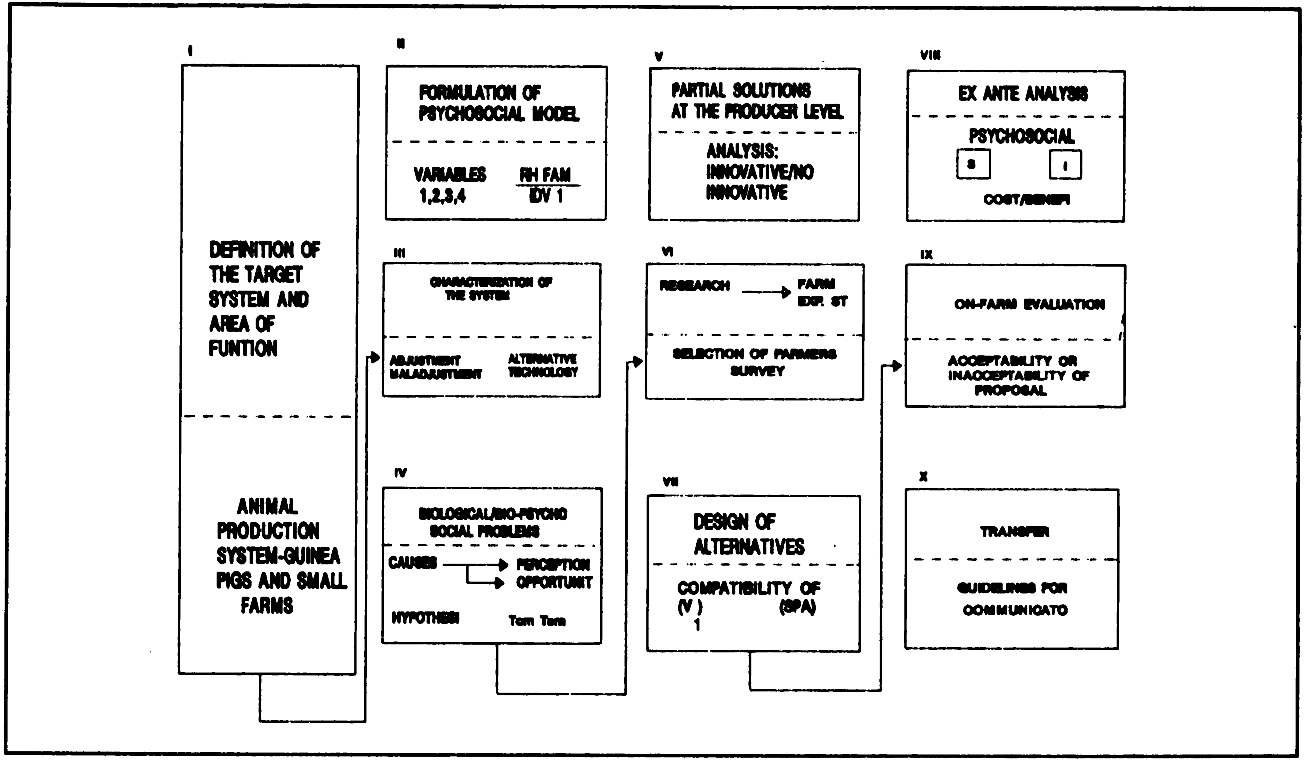

Fig. 1 **Stages of agricultural research using the systems approach: proposed methodology for phychosocial analysis.**

PREVIOUS RESEARCH

Only two previous studies have been carried out in Peru on the role of social psychology in systems-oriented agricultural research.

The first of these was a workshop entitled "The Application of Social Sciences in Production Systems Research: Seeking a Methodology" (Ruiz 1994). This demonstrated the usefulness of social psychology, given its ability to work with diverse variables pertinent to the production systems approach, relating to the producers' motivations and basic life objectives.

A second experience was the meeting on "Methodological Aspects of Social Analysis in the Production Systems Approach" (the source of this publication), at which one of the objectives was to evaluate the importance of psychosocial phenomena in the production systems approach, determining and characterizing variables, instruments, and analytical methodologies, as well as interpreting information that could contribute to the systems approach. The results are presented in this chapter.

The following summarizes the results of several research projects--conducted in the coastal, highland and jungle regions of Peru--and designed to identify the current "cosmic vision" of Peru's rural population. Although these studies did not use the systems approach, they do represent an important breakthrough in understanding "cosmic visions" and ecological systems in Peru. In this research, social psychology has worked hand-in-hand with anthropology and sociology.

Turner (1976) suggests that there is a link between the symbols and rituals of rural campesinos; therefore, in order to understand the native culture of an Andean, coastal or rainforest migratory group (in its rural or periurban setting), the group must be seen in the context of its place of origin.

It is possible to gain an understanding of such symbols from their principles or properties and multiplicity of meanings, pervaded as they are by ideas, emotions, standards and values, which, in a way, reproduce the reality. Thus, every symbol or code developed by human beings reflects their needs and, in the normative way of understanding, is a natural representation or evocation of something else, because of its analogous qualities or perceived association.

Rites are transitions between states, between fixed and stable conditions, where subjects or their groups develop the ritual in order to change or transform something. It is here that the symbol, that is, the need of the individual, is also related to the changing situation.

Every rite has three phases: the first involves the disappearance or externalization of the soul or vital energy, in which the subject or group distance themselves from their stable, everyday environment so as to enter the plane of the ethereal and mysterious. The second stage is the creation of a "new" reality introduced into the rite, known as suggestion, in which individuals give form to ideas or a set of possibilities that lead them to believe a thought as a reality and to change profoundly. And, finally, there is the consolidation of a new state when they are convinced that they have assimilated the new experience.

Geertz (1978) suggests that the vision of the world and the analysis of symbols means not only striving to understand the world of every individual, but also the historical, social, natural context in which they develop. It is in this dynamic that individuals reveal themselves as social beings, and only through this symbolic evidence is it possible to come to understand them and traditional or modern communities.

The term *ethos* means a vision of the world, considering existential, cognizable aspects. Furthermore, it refers to the quality of life as an individual's right; it means seeking an order in the real world, the concept of nature transformed into an idealized representation; it is beliefs or ideology, the way in which individuals and their societies interpret their life experiences and organize their individual or collective behavior.

A Quechua doctor (Covarrubias 1979) developed a dictionary that makes it possible to understand Quechua medical terms. In the hierarchical classification of terms, he points out that they are, for the most part, necrological, inasmuch as they express rituals for alleviating pain. Pain is conceived as the voice of approaching death while fever and sleep are conceived as ways in which the soul manifests itself and from time to time leaves the body of the sick individual. If children lose weight or height it is because their soul no longer wishes for earthly food, so illnesses are signs of death that continually threaten and dwell in places like ravines, lakes and rivers.

A number of studies (Alarcón 1969; Fioravanti 1979; Hildebrand 1979; Tomatis 1980; Camino 1982; Irrazabal 1983; Lopez 1987; Messini 1989) carried out on the coast, in the highlands and in the rainforest regions demonstrate the interrelationship between health and the balance of natural forces, in terms of energy or cold and heat, or in terms of the action of evil spirits and witchcraft vis-à-vis the non-traditional forms of healing that reestablish the natural and psychic balance.

PSYCHOSOCIAL VARIABLES IN SYSTEMS ANALYSIS

Based on the results of the studies mentioned in the previous paragraph, the following is a list of variables that may warrant further research, ranging from the most fundamental needs to social or secondary needs (Fig. 2).

Basic and psychosocial basic life objectives

- Satisfaction of needs that guarantee life: health, nutrition, food consumption, minimum environmental quality.

- Satisfaction of needs for pleasure, reproduction, love, sex and family.

- Satisfaction of needs such as being cautious, accepting submission, avoiding ecological hardships.

- Satisfaction of the need for personal and organizational development in terms of private and public life and level of aspirations, achievements and expectations.

- Satisfaction of the need to maintain a purpose and orderliness in one's life, such as: social, moral, ethical and intellectual values; success and development.

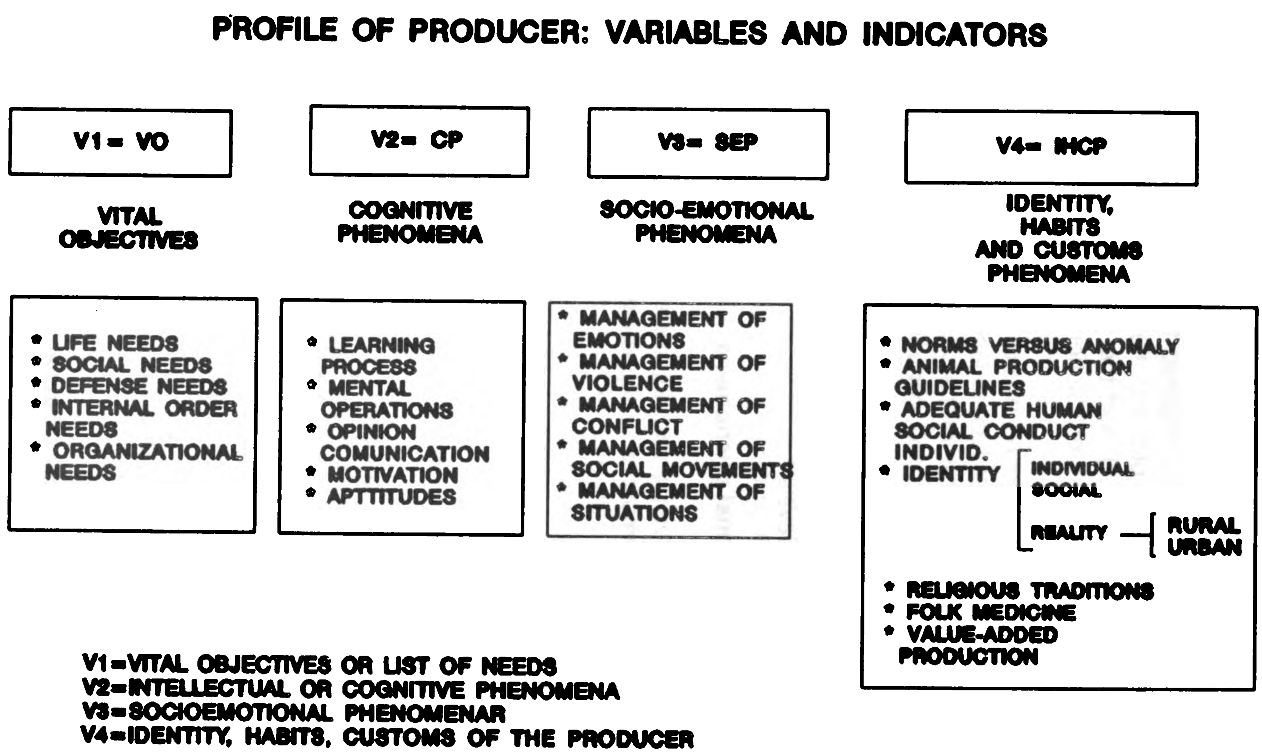

Fig. 2 Design of alternatives to proposed model.

Phenomena in the realm of knowledge or cognition

- Those relating to the first level of cognition: perceptions of the surrounding world ("cosmic visions"), observations of human conduct in isolation or compared to that of animals, individuals' awareness of the perceptions of their environment or the structure of their habitat (ecology), and the gathering and conservation of methods used in ancient production systems and technologies.

- Those relating to the second level of cognition: capacity for creative communication in either face-to-face or working group situations; reflection on and analysis of the concepts behind modern training techniques; promotion of community involvement in health-improvement programs through didactic materials that sensitize, motivate and produce changes of attitude--at the micromedia (leaflets, booklets, handbooks or manuals) or macromedia (radio, TV, videos, films) levels.

Psychosocial and emotional phenomena

- Those relating to simple, individual personal experiences, such as the handling of emotions: happiness, sadness, anger, anxiety, depression.

- Those relating to complex, social-personal experiences, such as: conflicts, revolutions and social movements.

Psychosocial phenomena of habits and behavior

- Those relating to the standards or patterns followed in children's upbringing, social conduct, social constraints in individual and collective life.

- Those relating to individual and societal identities with respect to the real world.

- Those relating to expressions of popular religious rites or handicraft production.

- Those relating to psychosocial factors that cause stress: alcoholism, drug addiction.

- Those relating to the added value of agricultural products.

These variables will be identified with and will affect the farming production system inasmuch as technological development is aimed at improving the farmer's quality of life.

METHODOLOGICAL INSTRUMENTS

Methodological instruments are essential for collecting, organizing and evaluating experiences. They may be either technical measuring instruments (surveys, questionnaires, scales, inventories, tests) or psychosocial interactive instruments (interview techniques, recreational-leisure activities, video recordings, personal statements). These instruments must have the capacity to measure certain phenomena and to make it possible to gather data that can be identified, organized and transformed into nominal or ordinal values (Fig. 3).

For any interdisciplinary research undertaking, both types of instruments should be considered. Their design and testing should be based on the observation of reality, practical experience and the general methodology followed in agricultural production systems analysis.

An example of a methodological instrument for the analysis of one psychosocial variable regarded as having priority: "Basic life objectives in agricultural production."

An inventory of basic life objectives has been designed to find out what it is that farmers expect to get out of their agricultural system in their everyday life. Use of this instrument will make it possible to discover what things they desire above all else, as well as the things that they do not care about at all. This in turn will produce a basic profile of the farmer's everyday life. However, it is a given that the conscious or preconscious evaluation of basic life objectives at the individual level is not necessarily the same as the conscious or preconscious preferences of all the members of a community.

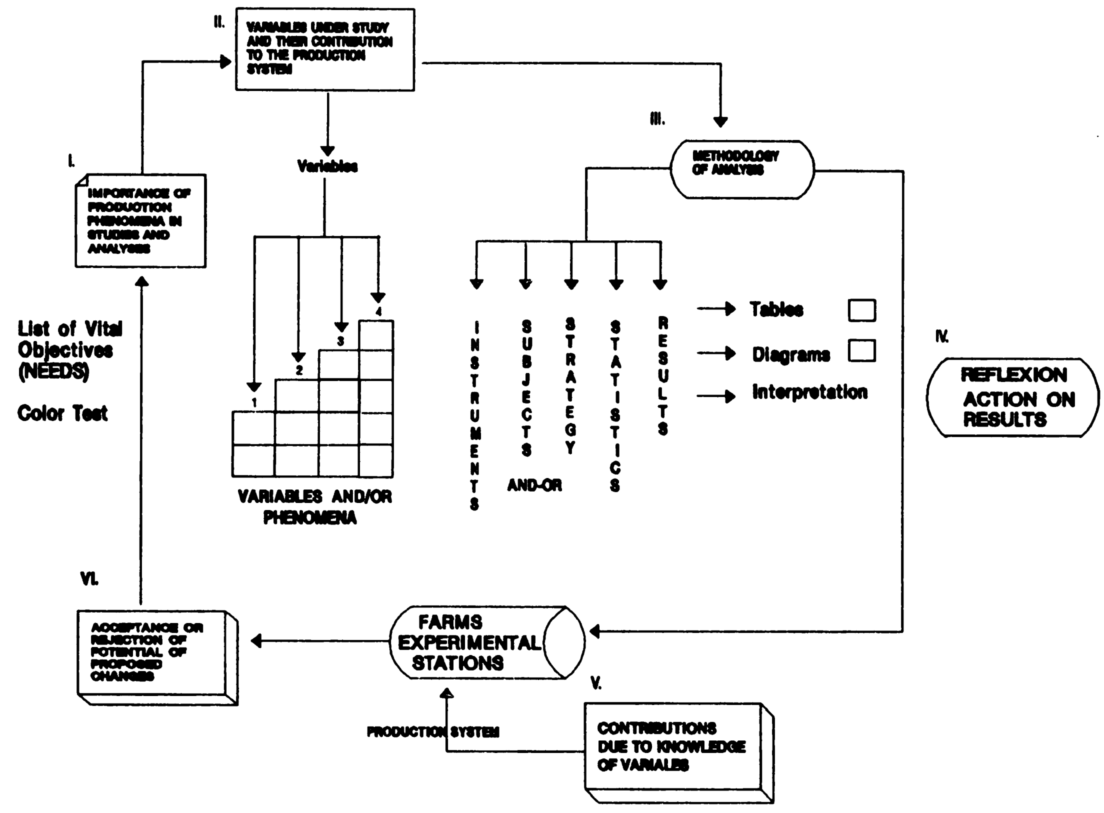

Fig. 3 Methodological aspects of psychosocial analysis within the production systems approach.

The principles of this basic life objectives inventory are given below; for full details, the reader is referred to Annex 2.

Variables required. These will depend on the size of the population studied, the number of samples, and whether the latter are for case studies or for comparisons among groups (for example, experimental and control groups).

Control variables

- Literate farmer (the measuring instruments can be technical and/or psychosocial interactive).
- Illiterate farmer (the most suitable instruments are psychosocial).
- The farmer's age.
- Sex.
- Occupation.
- Productive activity in which he/she is engaged.
- Length of residence in the area.
- State of physical and mental health.

Independent variables

Independent variables are contained in a list of 40 questions on basic life objectives, which can either be answered alone or in a group, within a time limit of 20 minutes. The instructions are read out and the examiner must ensure that individuals mark their answers on the answer sheet--which should be separate from the text so as to facilitate tabulation and the subsequent calculation of the score.

These 40 questions are answered by marking (with an X) the numeric values that are used in the answers: 5 for "essential", 4 for "important", 3 for "desirable", 2 for "of no interest", and 1 for "rejected". The nominal categories represented by these numeric values are:

E = *Essential*: an objective that is absolutely necessary for life to continue.

I = *Important*: a priority objective, but not absolutely essential for survival.

D = *Desirable*: an objective that would be gratifying but is not absolutely essential to lead a good life.

N = *Of no interest*: an objective that is of no significance; however, the individual looks at it.

R = *Rejected*: an objective that is neither desired nor necessary.

Dependent variables

The profile characterizing the basic life objectives is obtained by adding up the scores for each answer; it will show what the farmer most desires and which of the above elements are least important to him/her. This analytical profile is presented in tables and charts organized in percentiles that indicate individual scores and the group average.

Statistical analysis of the data. The subjects of the research can be divided into different farmer groups (e.g., guinea pig producers versus rabbit producers), based on large differences in specific basic life objectives.

The verification of hypotheses is done through a Student's *t* test regardless of whether samples are of equal or unequal size. The formula for these cases are:

When samples are equal in size:

$$t=\frac{\overline{X_a}-\overline{X_b}}{\sqrt{2S^2/n}},g.l.=2(n-1)$$

When sample size is unequal:

$$t=\frac{\overline{X}_a-\overline{X}_b}{\sqrt{S^2(n_a+n_b)/n_a n_b}},g.l.=n_a+n_b-2$$

The analytical conditions for final decisions on the comparisons are given below:

If the calculated *t* is greater than the tabulated *t* value, the proposal is accepted; if the calculated *t* is smaller or the same as the tabulated *t*, the hypothesis is rejected.

The working probability level is usually .05 and the degrees of freedom will be 2n-2 in the case of samples of equal size. A normal distribution curve may be drawn where the side areas (the tails of the curve) pertain to the region of rejection of the null hypothesis, at the given probability level, and the central area pertains to the region of acceptance of the null hypothesis.

Case studies can be used as a brief but meaningful rapid rural appraisal, as was done in Cajamarca with the guinea pig farmers, where measuring instruments such as the color test proposed by Lüscher (1974), developed in a Dutch rural research project, were used. The goal was to discover the significance of colors used in paintings, ceramics and weaving, with the author concluding that farmers project their knowledge, their balance between outlook and essence, as forms in which they envision their world and personal characteristics. This vision is associated with psychological and physiological needs, since people tend to develop protective adaptational strategies both for the inner self as well as for their behavior in respect to the world surrounding them. Furthermore, Lüscher concluded that all research involving color tests will provide information on ways mental states are projected, as well as on the hormonal equilibrium, which is universal regardless of race, creed, sex and surroundings and makes it possible to gain a vital insight into human beings and their environment.

The inventory of basic life objectives is based on the work carried out by Bühler and Coleman (1962) concerning the satisfaction of the four basic needs in life: (1) the primary or essential needs; (2) the secondary needs, in other words those involving internal and external adaptation to, or defense against, the environment or context; (3) the need for creative expression; and, (4) the need to maintain internal order. The authors' basic assumption is that all human beings have needs that operate at different levels of urgency varying according to age, state of health and the characteristics of their habitat.

The ultimate goal of the test on basic life objectives is to determine the level of well-being and achievement in terms of satisfaction or limitations. These values are determined by the inquisitiveness and aspirations of individuals, their community, and their organization; their satisfaction or dissatisfaction can be taken as indicators of capabilities and weaknesses, which should be taken into account when formulating development proposals.

Results. Findings can be presented in the form of tables, charts and graphics setting out aggregate scores, percentiles, and representative percentages by levels and areas of analysis. These should contain a qualitative analysis of the results, indicating why and how they were obtained, what was observed and what conclusions can be extracted. The following section illustrates this part of the process.

RESULTS OF PSYCHOSOCIAL TESTS CARRIED OUT AMONG FARMERS PERTAINING TO RISPAL'S GUINEA PIG PRODUCTION SYSTEMS PROJECT

As part of the workshop that generated this publication, a pilot study was conducted to experience a hands-on application of psychosocial tests. The interview involved six families whose mixed production systems combined the raising of guinea pigs with the cultivation of crops for both household consumption and sale (see Annex 2). The range of crops included pastures, alfalfa, potatoes, oca, barley, wheat and fruits such as limes, peaches and prickly pears. These systems comprised both irrigated and rainfed plots. The livestock component consisted of cattle, swine and poultry, as well as guinea pigs. In addition, the families interviewed engaged in other nonagricultural work such as the operation of a cereal mill, restaurants and retail sales.

The average extended family was composed of 15 members, all of whom took part in agricultural activities; the women took care of the harvesting and threshing, while the men handled the remaining farm and livestock duties and adolescents and smaller children were responsible for the raising of guinea pigs and poultry.

The homes of the families interviewed consisted of multipurpose spaces: bedrooms that doubled as larders and storage areas for seeds, tools and equipment. There was also another area which included both a place for cooking with a wood stove and multipurpose animal pens. There were no latrines or flushing toilets.

The design of the living area was in keeping with the lifestyle of these families. They had no furniture (soft chairs, closets, etc.). When asked why they had no soft chairs, they replied: "We sit anywhere, not just on chairs, but on stools or on the floor". Their organization of space was open-ended. Their home was only a stage for the activities they performed each day.

Table 1 provides a summary of the average scores obtained by the families interviewed with regard to their basic life objectives.

Table 1. General averages of aggregate scores obtained by guinea pig producers in Cajamarca tested on their basic life objectives

Average score	General level of satisfaction of basic life objectives
150.73	75%, Level II (Satisfied)

The test indicated that 75% of the guinea pig producers possessed the basics of life and their survival was assured (i.e., their basic life objectives were satisfied). Their subsistence economy was one of families with mixed production systems--a type common in Cajamarca province.

Table 2 presents the analytical summary by area, based on the test on basic life objectives.

Table 2. Analytical summary of the basic life objectives test, according to need

Area of need	Average score	Level of satisfaction
1.Radical needs	31.33	Important to 75%
2.Secondary needs	30.50	Important to 75%
3.Defense-cautiousness	20.80	Unmet, 50%
4.Development and creative expansion	32.50	Essential to 90%
5.Maintenance of internal-external order	35.60	Essential to 90%

Given that the pilot study farms are small farms with mixed production systems and a diverse range of crops, their economy was geared toward household consumption and barter, with few items purchased. Their needs in area 3 (Defense-cautiousness) remained largely unsatisfied, since these farmers faced the dangers of frosts, against which they were unable to take preventive measures. They had no alternatives or substitutes to compensate for the lack of fresh forage, nor did they take steps to protect the health of their guinea pigs. These producers were not equipped to cope with fluctuations in supply and demand and variations in the price of guinea pigs, even though they themselves stated that such situations were avoidable.

Table 3 shows the results of the Lüscher color test as applied to the families of guinea pig producers.

Table 3. Summary of results of the color test: colors most often preferred by guinea pig producers.

First choices	Last choices
Brown and grey	Red and black

The implications of the colors noted were confirmed by the opinions manifested by the producers themselves.

Brown. This color indicates the great importance attached to land, demonstrating that Cajamarca's guinea pig producers possess agrocentric concepts: "The land is the only dwelling place that we old peasant women have, things spring abundantly from it, and peasants like me, my dear doctor, take care of it because we belong to it and we shall become part of it..." "my mother used to tell me that the *mamapacha* (mother earth) has put up with being trodden underfoot by strangers in many ways, but like all mothers she is generous, health and wealth issue from her..."

"...You know, when I was seven my mother used to send me to wash the guinea pigs in the thermal waters, it killed their lice and their fur grew thick and long, the grains of corn were big and the air was fresh, you know, my dear doctor, one jealously guards the things that she taught, that's what I tell my only son Segundo..."

What do you think about death? What will happen to Segundo then? "Uhm..., he'll know; the fact is I'm old, I fall asleep along the road, I get too tired, and my neighbors put my animals into the corral in the afternoons. I can't see very well and I stumble along the river banks when I go to buy oil or sugar. Uhm, but before I die, please come; I want to show you something" (she pointed out a sow with five toes); "She's from a very old litter and as she's old, I'm going to eat her on July 28[2]. I hope you'll come then, eh?... Of course you will, he who promises keeps his word, he who came once will return to my land". (Olinda V., 75-years old).

Grey. This color indicates states of anxiety that are created when individuals or their communities are unable to attain their objectives. This color is present in the backgroud of all textiles, blankets, saddle bags and rugs. People say that it is like the fog that rolls down on winter evenings from the *apus* (snow-capped mountain-tops,) or like a frost (the campesinos of Cajamarca view frost as a source of hardship as it destroys their crops).

Black. This color reflects loss of hope and respect for authority, alternatively. It is thought that the despair of the guinea pig producers is

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2 Peru's Independence Day (Editors' note).

due to the fact that they do not know how to cope with climatic phenomena such as frosts or the heavy rains that make their guinea pigs sick (they catch colds) and also swell the river; snakes and scorpions are attracted by the animals' body heat and bite them.

Another connotation of the color black is as a sign of mourning for the death of Atahualpa. Since that day Cajamarca's peasants have worn a black pin on their hats as a mark of respect for authority; this respect for authority can be extreme, as shown by their submission to outsiders. It would appear that the latter's arrival is interpreted as heralding new experiences and is therefore welcomed. (It is worth recalling that a centuries-old trait of the people of Cajamarca was that when they defeated other peoples and these were peaceful, they respected the conquered people's beliefs and celebrated their feast days).

Red. This color represents willpower and the energy to accomplish things. An example of remarks made in regard to the color red in their handcrafted objects is: "...look, this pot has a black ladder, but on the front there is a red one that compensates for the great sadness it harbors; therefore, you will never lack food..."

CONCLUSIONS

To sum up, the results of the test on basic life objectives and ways of life (color test) revealed that the families engaged in guinea-pig production have capabilities and basic life objectives that have been satisfied, although there were weaknesses that hindered or affected these producers. Based on these characteristics, presented below are some proposals put forward by the producers themselves and suggestions from the social psychology field regarding technology transfer options.

The capabilities identified include the following:

- They are patriarchal families, accustomed to assisting one another.
- They are agrocentric families, attaching great importance to the land.

- They are families with a great capacity for creative expansion and adapt easily to their environment. They are, moreover, families with heterogeneous or multiple work activities, simultaneously managing several crops and types of livestock and other sources of income.

- They are families with a value-oriented cultural identity and reciprocal labor arrangements, with all their members participating. The labor force is a strategy for social support the use of which is driven by a conviction that production must be increased; thus, these families always seek other new and creative sources of income (for example, mills, honey, guinea pig raising, food storage).

On the other hand, these families exhibit certain weaknesses:

- They are not organized to cope with variations in the market, prices and costs of their products.

- They have no potato seedbeds; no insecticides, pesticides, nor access to the credit that would enable them to obtain them.

- There is no animal health prevention; they are not familiar with the causes of the diseases that strike the guinea pig population, which obviously reduce production.

- They do not make use of traditional practices in raising farm animals, such as the use of thermal waters either as hydrotherapy or for hygiene.

- There are no health improvement programs or integrated preventive medicine for producers; illnesses that can be avoided are rampant: diarrhea, infections of the sensory organs and skin and deficiencies of vitamins A and E. All these could be prevented through a health program.

Based on this study, it is possible to define the following alternatives and working proposals:

- Training in control and prevention of the most frequent diseases that affect guinea pigs.

- Production of teaching aids dealing with human and animal health prevention.

- Promotion of the active participation of young people and children in guinea pig production

- Promotion of rural organization and training of campesino leaders, by region and by community, who would then take charge of the administration and marketing of guinea pigs (and other agricultural products) at the local, regional and national levels.

In short, in production systems research, knowledge of the psycho-social variables and phenomena would make it possible to compare ex-ante and ex-post social evaluation criteria for technological alternatives. This would facilitate the development of proposals seeking improvements in agricultural production, social organization and well-being of the people involved. The results derived from the application of the production systems approach, in addition to enriching the methodology, should be offered to the producer organizations as feedback.

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METHODOLOGY FOR THE ANALYSIS OF SOCIAL AND CULTURAL PHENOMENA

Ricardo Claverías[1]

INTRODUCTION

This chapter presents a methodology for researching and analyzing the roles of culture and social organization as either constraints or facilitators of production development, with particular reference to the introduction of technological innovations.

The conceptual framework used to explain the role of sociocultural phenomena on technological change is the systems approach and interdisciplinary work. Field trials carried out in farming communities in the mountainous regions of Peru (particularly in the north and south of the country) are cited to support or clarify the theoretical framework proposed.

IMPORTANCE OF SOCIAL AND CULTURAL PHENOMENA IN THE ANALYSIS OF PRODUCTION SYSTEMS

The systems approach is a useful tool for understanding and analyzing the multiplicity of subsystems (crop production, livestock, handicraft production, and others) and the components of particular agroecosystems. The sociocultural subsystem, however, also has a crucial impact on decision-making insofar as the structure, function and reproduction of production systems are concerned (especially in small, resource-poor rural systems), for the following reasons:

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1 Senior Researcher for the Andean Production Systems Research Project (INIAA-PISA). This chapter was originally commissioned by the INIAA-PISA Project as a paper for the Second Workshop on "Methodological Aspects of Social Analysis in Farming Systems Research," held in Cajamarca, Peru, and organized by RISPAL and CE&DAP.

- In these systems, decisions regarding production or technological innovations are exclusively controlled by the farm households concerned and not by any commercial enterprise. Therefore, in order to understand the logic behind the processes involved in agricultural production systems, researchers first need to gain an understanding of the *rationale* of campesino families (their objectives, the resources at their disposal, and the uses to which their production is put).

- In the generation and transfer of technology, priority should be given to those techniques which are not only best suited to the agroecological zones involved, but that also take into account the sociocultural constraints of campesino households.

- In proposing technological alternatives, researchers must acknowledge the fact that campesinos do not have a homogeneous economy or set of resources, as there are actually distinct *social strata* (families belong to the "upper," "middle" or "lower" strata). Accordingly, there is a need to study the disparate social and cultural objectives of each stratum, with a view to proposing alternatives tailored to their different needs.

In short, the sociocultural subsystem is both a starting and a concluding point for technological research: as a starting point, because it enables researchers to understand the reasons why families structure their production systems in a particular way; and as a concluding point, because producers also have sociocultural reasons for accepting or rejecting a new crop or product. Any new product must fit the family's dietary preferences; likewise, the decision as to what and how much cash crops to plant is also determined by the market expectations of rural households (Plaza and Francke 1981; Gonzales de Olarte 1984; Mayer and Cadena 1989).

HIERARCHIES, UNITS OF ANALYSIS AND THE MAIN VARIABLES: RATIONALE AND DECISION-MAKING

In order to study rural households (the social cornerstone of the production process in traditional agricultural zones) as a *unit of analysis and observation*, researchers must first familiarize themselves with the factors that influence the production/technology-related decisions taken by campesino families (viewed at this level as a *decision-making unit*). This, in turn, will enable them to identify the different hierarchical levels of the socioeconomic environment within which rural households operate.

External social factors: The region and the microregion

The socioeconomic environment or context is composed of two hierarchical levels: *the region* (country) and *the microregions*, which contain economic and social factors that campesinos use as criteria in their decision-making processes. Consequently, the socioeconomic context should be used as the starting point (i.e., the *macro-level* basis) for the formulation of technological options for farming systems (the *micro-level* operating unit). Figure 1 summarizes the external criteria that must be taken into account in identifying and formulating technological options. They are discussed below:

The objectives of the regional and national system must be understood. A characterization of regional dynamics is of key importance and should be based on two kinds of variables:

> *Economic variables*: The needs of the regional and microregional society, the production pattern, the supply and demand governing the products for which the project wishes to formulate technological alternatives, and pricing dynamics (or terms of barter).
>
> *Social variables*: These call for an analysis of the social needs of the region and microregion as part of an effort to develop strategies leading to food security in the region. The social variables for this analysis are indicated in Fig. 1.
>
> Other external factors that also need to be studied include the State's role, its agrarian policies and the impact that these policies (prices, credit and subsidies) have on agricultural production.Several aspects of the regional process of which the agrarian communities under study form part should be analyzed. These include the pattern of urban growth (as an indicator of potential demand for farm products), industrial development and how it interfaces with the rural sector, and marketing systems (Agreda et al. 1988).

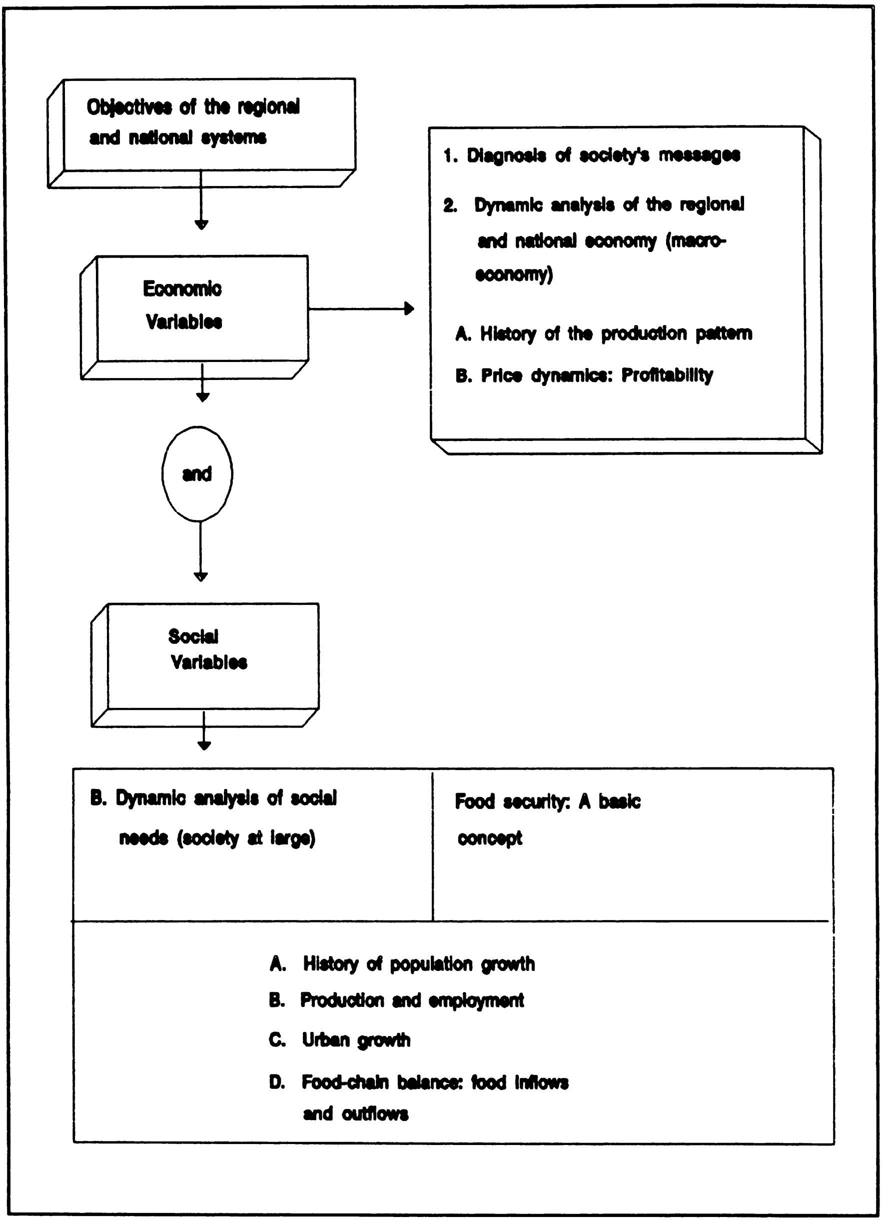


Fig. 1 External criteria for the formulation of technological alternatives: The region and micro-regions (macro level)

The microregions must be taken into account. This criterion is important because microregions are an intermediate hierarchical level between the region and the communities or rural households, and because their analysis provides an understanding of the way in which production and barter relationships between campesino families and the microregions are structured. These studies should be made at the following levels:

The agroecological zones present in the microregion (see Fig. 2) and the communities contained in those zones.

The rural and the urban settings, and their interactions. The study of the urban setting should include market dynamics and how these impact the rural setting, local power, and the technological organizations and services based in the cities.

Particular emphasis should be placed on the study of fairs or street markets, not only in terms of the supply and demand of products in general, but chiefly because the technological inputs available at 0these fairs (e.g., fertilizers, agricultural implements, seeds and breeding stock) are indicative of the technological demand in the region.

The study of these external factors helps researchers understand the reasons why campesino families make specific production- or technology-related decisions in harmony with the objectives of the regional or microregional society.

Internal social factors: The campesino rationale

The following are the internal factors involved in the decision-making process of rural households, factors that must be identified if technological alternatives are to be characterized and formulated:

Producers' objectives and aims (see Table 1). The objectives of the different social strata of a given farming community must be determined. For example, a group of families from the upper stratum may be more interested in livestock development and, therefore, in crops having a dual purpose: (1) as food for human consumption and (2) as animal fodder. On the other hand, families from the lower strata may be interested in other crops for different purposes.

As shown in Table 1, researchers must determine the limits and opportunities of each family and stratum in relation to the adoption of new technologies, the families' objectives, the behavior of the different social strata, and even their secondary objectives: is the production of the families geared more toward household consumption or sale, and what kinds of crops are involved? Only by studying the rationale of rural households can researchers develop a matrix of technological demand, taking into account the socioeconomic factors outlined previously and the concepts used by campesinos in planning their production strategies (Fonseca and Mayer 1988).

Table 1. The objectives and purposes of producers' systems (micro socioeconomic and cultural)

1. THE LIMITS OF THE SYSTEM: OBJECTIVES AND ENVIRONMENT.
2. OBJECTIVES, RATIONALE AND BEHAVIOR, BY TYPE OF PRODUCER.
3. PRIMARY AND SECONDARY OBJECTIVES.
4. CRITICAL KEY ELEMENTS WHOSE MODIFICATION CAUSES GREATER CHANGES ON OTHER ELEMENTS.
   - A. OBJECTIVES FOR REACHING SELF-SUFFICIENCY PRODUCTION.
   - B. OBJECTIVES FOR MAXIMIZING PROFITS.
5. DEVELOPMENT OF TECHNOLOGICAL DEMAND MATRIX, BEARING IN MIND:
   - A. ABOVE POINTS 1, 2, 3, 4.
   - B. BASIC CONCEPTUAL MATRIX.
   - C. MESSAGES OF SOCIETY'S OBJECTIVES (MACRO).

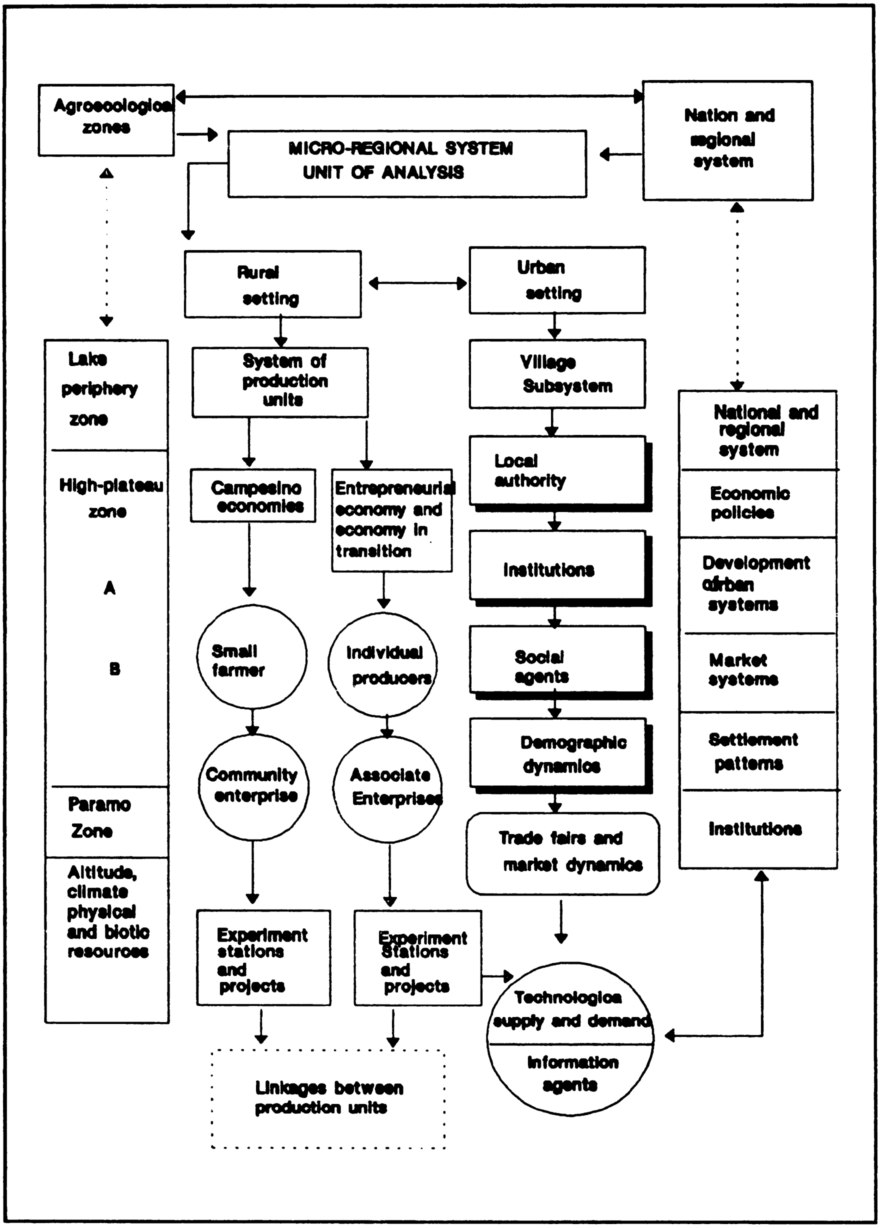


Fig. 2 Micro-regional system (setting).

Consumption habits and comparative advantages in the market. Other Important factors that impact the production-related decisions of campesino families include their attitudes, their beliefs about the importance of certain foods, their preferences and the impact of family and local festivities (Hartog and Staveren 1983; Muñoz 1989).

The interpretation of climatic indicators and the concept of agrosystems within the family unit.

The ebb and flow of migration and new attitudes for the adoption of technologies allow new crops to be introduced into the farm unit.

Social relationships, such as reciprocal cooperation, barter between households, and communities located in different agroecological zones also influence technology-related decisions.

In short, some factors that have a bearing on the decisions taken by campesino families are part of the external environment; these include the State, the region and the microregions. On the other hand, the internal factors that affect the farmers' decision-making process are their objectives and aims, the concepts that guide their behavior, their consumption habits and comparative advantages in the market, the observation and interpretation of weather or climate, migratory movements, and social relationships (including religious relationships).

Methods, variables and analytical instruments: The family as a unit of analysis

In general, researchers employ the scientific method (identification of the problem, hypothesis and conclusions or axioms); this method does not lead to solutions or validated alternatives, but rather to theoretical conclusions. In contrast, as R. Cañas (1989)[2] pointed out, though the technological method also starts out by analyzing the problem and proposing hypotheses, unlike the previous method it seeks possible solutions and evaluates the various alternatives. The technological method

2 Personal communication.

also attempts to rank the alternatives from a social standpoint, defining two units of analysis and observation for this purpose: (1) the community or any type of organization of campesino families, and (2) the campesino family itself.

The campesino community: The community assembly

In the Andean rural setting, rural households organize themselves into communities (which are recognized by law). Such forms of community association do not exist in other regions, although there may be other kinds of peer organizations. In any case, the gathering of information and ranking of technological options may use the same method described below.

In Andean communities, households meet on a monthly basis to discuss any problems that have arisen in the community and arrive at possible solutions. These meetings are also used to plan the social and technological strategies required to further enhance production. For these reasons, it is important that the method of analyzing community assemblies be used to rank projects and technological alternatives for the communities concerned (Claverías and Tumi 1988).

Table 2 cites the example of the Apopata community, located in Puno, Peru, at some 4500 meters above sea level. The topics discussed were recorded by referring to the minutes of meetings (the technique involved follow-up and direct participation in these meetings for at least a year or one complete farming season).

The topics discussed by the families were tabulated and divided into three categories (Table 2): (1) those involving technological innovations and agroecosystem management; (2) the adoption of new technologies; and (3) community problems. Then the researchers noted the frequency with which these topics were discussed during 1988 and 1989, and the internal (the community) and external (PISA project or others) institutions that became involved, due to their interest either in the subject or in the solution to the problem.

The campesino family: Structure and function

The campesino family is the basic unit of analysis; only at this level is it possible to identify the family's main characteristics (structure and functioning), as well as the technological and social alternatives available to bring about its development.

The phases and methodological processes involved in research on the family unit are as follows:

1. Problems and hypotheses

The production systems of campesino families face many problems--problems that may lie in the area of livestock management, pastures or crops. These problems must be ranked according to the objectives and limits of the system. In each case, researchers must determine whether any existing solution has a bearing on the producer's objectives. A working hypothesis for the research can then be proposed.

2. Methodological instruments: Variables and analytical methods

Surveys, interviews, observations and records are some of the techniques used to gather information; however, a strategic element in social research is the definition of the variables and analytical methods to be used to study the structure and function of rural production systems at the family level. The possible variables and analytical methods are presented in Fig. 3 (from the work of E. Maydana, as part of the PISA project). Each variable describing the household economy is analyzed statistically, the interrelationships between variables being studied at the same time.

The purpose of studying these variables and their interrelationships is to identify and analyze the social groups or strata that make up each campesino community and the prospects for technological innovation.

3. Exercise for the implementation of the methods proposed: The case of the Anccaca community

A study of the Anccaca campesino community (Puno, Peru) carried out by the PISA Project in 1989 and 1990 is presented by way of illustration.

Table 2. Topics and activities scheduled in community assembly: Apotata (1988-1989)

TECHNOLOGICAL INNOVATION AND MANAGEMENT OF INSTITUTION AGROECOSYSTEMS (PRODUCTION)	FREQUENCY No.	%	PARTICIPATING INSTITUTIONS
TRADITIONAL:			
1) Extention of marshlands	3	4.2	The community
2) Cleaning and repair irrigation ditches. (April-May)	1	1.4	The community
3) Cleaning of marshlands (April-May)			
4) Fertilizing marshlands with guano	1	1.4	The community
(Sept.-Nov.)	1	1.4	The community
5) Selection of marshlands			
	2	2.8	The community
6) Construction of irrigation channels by sector			(February/March)
	1	1.4	The community
SUBTOTAL			
	9	12.6	
ADOPTION OF TECHNOLOGY:			
1) Introduction of winter wheat	2	2.8	PISA-INIAA
2) Health assistance	4	5.6	PISA-INIAA
3) Fencing pastureland	1	1.4	PISA-INIAA
SUBTOTAL	7	9.8	
MARKETING PROBLEMS:			
1) Sale: prices of fiber and meat	7	9.7	The community
2) Purchase: food and health	5	6.9	The community
SUBTOTAL	12	16.6	
COMMUNITY PROBLEMS:			
1) Elections and community enterprise (livestock and loans)	10	13.9	The community, The State
2) Community-owned land	4	5.6	The community
3) Formal education and religion	6	8.3	The community
HANDICRAFTS COMMITTEE:	10	13.9	PISA-INIAA
FAMILY AFFAIRS:	5	6.9	The community
TRAINING:	4	5.5	PISA-INIAA-PAL
NUTRITION:	5	6.9	ONA-PISA-INIAA
SUBTOTAL	44	61.0	
TOTAL	72	100.0	

This research set out to explain the variations in the attitude of rural households (by strata) toward the adoption of new livestock and crop production strategies. The hypothesis formulated was that households from the upper stratum--with more land and capital at their disposal--do not have a prime interest in tecnological alternatives for the improvement of crop production, since their main interest is in livestock; these households would therefore be more receptive to the adoption of alternatives that would improve their animal husbandry practices. The priorities of households from the middle and lower strata, however, would be the exact opposites of those of households from the upper stratum.

However, the lack or abundance of operating capital does not automatically determine the adoption or rejection of new technologies. It is more important to determine the rationale of the different kinds of campesino units in order to explain why some are more efficient than others in adopting technologies for specific crops or animal species.

One methodological process for such analysis would be as follows:

- Select variables and statistical methods (see Fig. 3).

- Analyze each variable; for example, the variable *agricultural land use* can be disaggregated as:

  TL = total landholding
  CL = cultivated land
  FL = fallow land
  NP = natural pastureland

- Conduct a factorial analysis for the dependent variables (e.g., land use) according to the following random effect model:

  $$TL = b_o + b_1CL + b_2FL + b_3NP + \Sigma_i$$

  in order to arrive at a final model which explains in statistical terms the common elements in the land use practices of campesino families, the ways in which they differ, and land use priorities by groups of families.

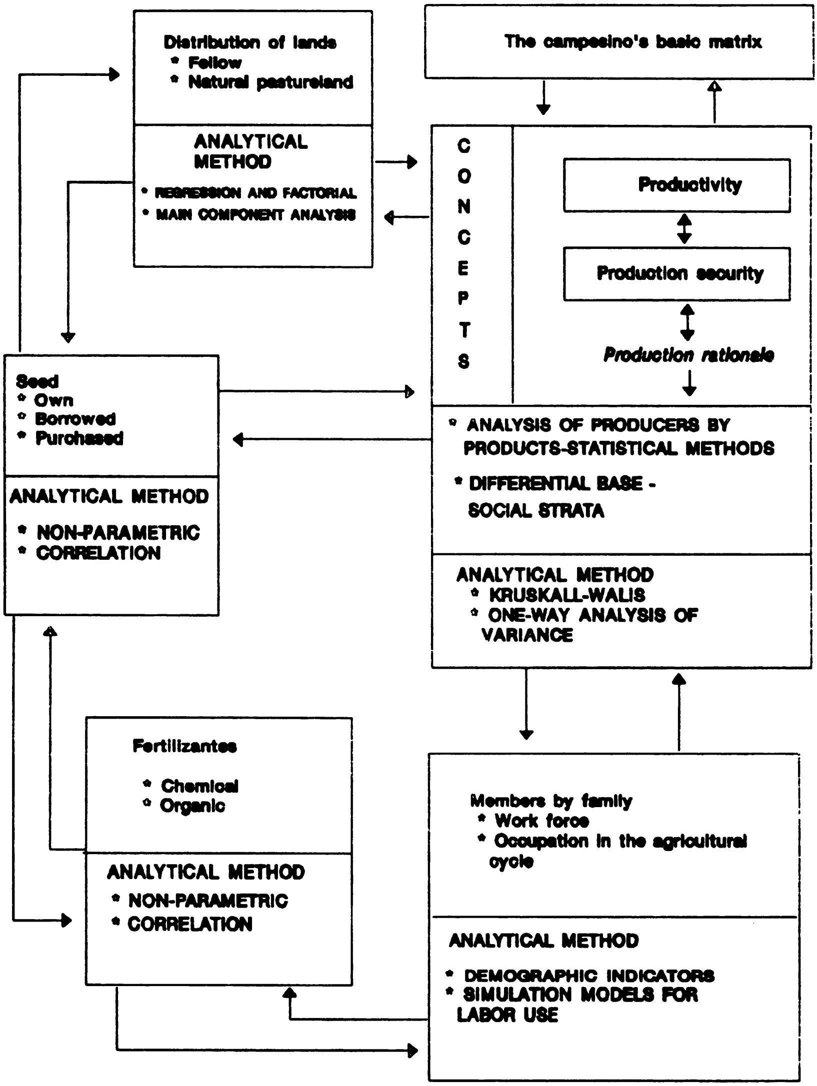


Fig. 3 Summary of variables studied and analytical methods.

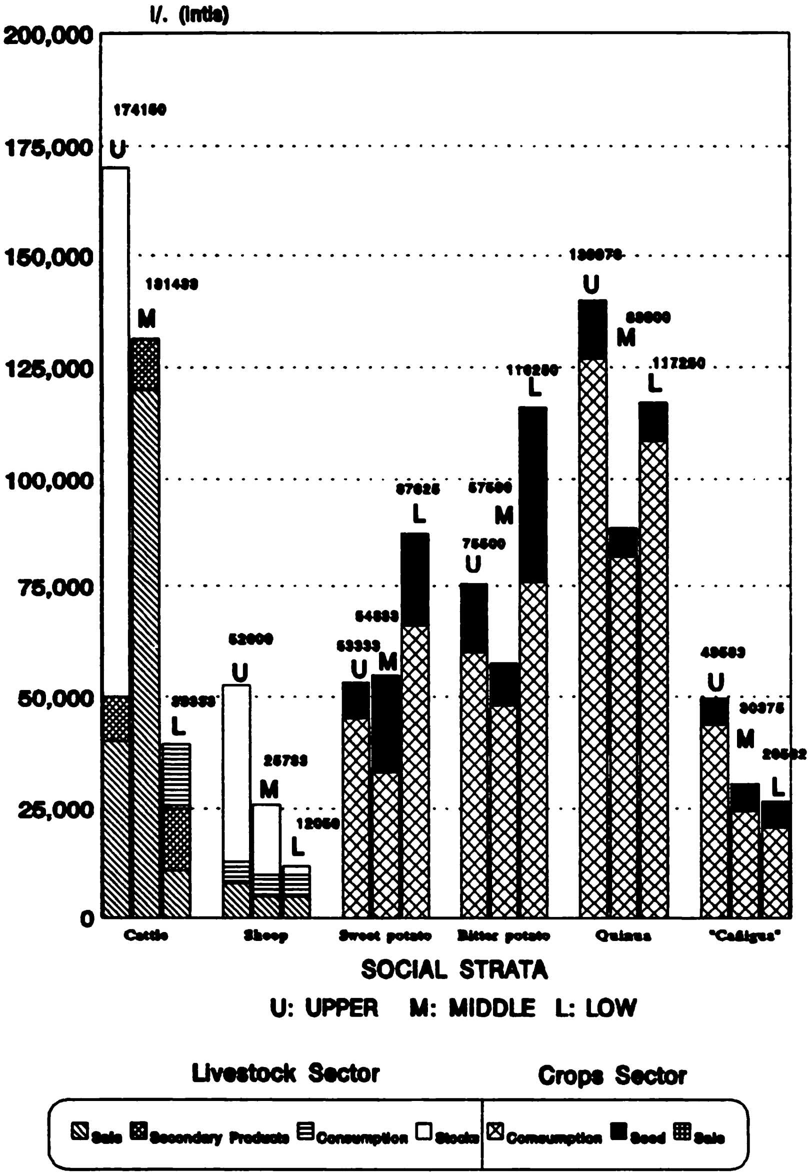
- Conduct an analysis of variance to differentiate the ways in which families divide up their land for cropping or grazing or allow it to lie fallow. In addition to the analysis of variance, given that a random effect model was used, Scheffé's test for each range of means (Snedecor and Cochran 1982) can also be used; the level of significance usually chosen is 0.05.

- Formulate a matrix in which the social strata are logged along the vertical and the dependent variables (total land, cropland, fallow land and pasture) along the horizontal. Scheffé's test, at the base of the matrix, will indicate whether all the groups (or strata) differ from one another, the extent of any differences, or which groups are similar to one another, insofar as the variables analyzed are concerned.

- Analyze each category of land use by social stratum, for example, the use of land for crops. Among the best methods for this statistical analysis is that developed by Kruskal-Wallis (1952) and Scheffé's test for range of means.

- If significant differences in land distribution are found, the other variables can then be analyzed in relation to those already mentioned. This analysis should consist of studying (according to social stratum) the differences or similarities in the behavior of campesino families engaged in crop and livestock production and distribution.

The results of the analyses of how families use the land, livestock and crops, according to social stratum, and of how these production components affect income, are presented in Fig. 4. The rationales of the various strata of rural households can be differentiated by the following features: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54833
M
87625
L
75500
U
57500
M
116250
L
U
M
117250
L
49583
U
30375
M
L
Cattle
Sheep
Sweet potato
Bitter potato
Quinua
"Cañigua"
SOCIAL STRATA
U: UPPER M: MIDDLE L: LOW
Livestock Sector
Crops Sector
Sale
Secondary Products
Consumption
Stocks
Consumption
Seed
Sale

- The upper social stratum has more cash income from livestock production (cattle and sheep), with the emphasis on cattle.

- Crop production (especially the production of potato and bitter potato) is proportionally greater among rural households of the lower stratum than among those from the middle and upper strata.

- Nonetheless, crops such as *quinua* and *cañihua* are more commonly found among the members of the upper stratum, the reason being that these crops serve a twofold purpose: they provide, food (grain) for the family and fodder (the crop residue) for livestock.

In conclusion, the main idea of the lower stratum, who have little land at their disposal, is to ensure a level of output that guarantees survival (but at a low cost, as is the case of crop production). In contrast, the objective of the upper stratum, who own more land, is also to ensure survival (with a few crops) but, primarily, to guarantee production that enjoys comparative advantages in the market (as with cattle, for example).

Therefore, the people who would be most interested in the adoption of new, but low-cost, agricultural techniques would be the members of the middle and lower strata; households from the upper stratum, on the other hand, would be more interested in improving their livestock management techniques or the agronomy of their pastures or the production of *quinua* or *cañihua* (as dual-purpose crops that are less labor-intensive).

REPRODUCTION STRATEGIES IN CAMPESINO FAMILIES

The systems approach has nearly always been used to ascertain how the components of a given household economy are structured and how they function (the system's inputs and outputs and the internal processes); but insufficient progress has been made in determining how each element--and the entire production system- is reproduced (Burgos 1988).

In this section, an attempt is made to briefly explain, in sociological terms, the way in which household economies are reproduced --in other words, how they guarantee that the various components will be present in the following year (both technological components, such as seed, and socioeconomic components, such as labor and operating capital).

It is proposed that, when addressing renewable resources and inputs such as seed and fertilizer, farmers should be asked not only how much seed was planted over the year, but also how they came by the seed used for the different crops or how they acquired the breeding animals necessary for renewing the herd.

The methods used to acquire each element or component of the different subsystems managed by a campesino family vary from one social stratum to another. In the upper stratum, the purchase of seed or young bulls may be the most important step in preparing for the new farming year. On the other hand, reciprocal cooperation may be the method used by the lower stratum to obtain the components required for beginning the farming cycle again. The different ways in which inputs (whether seed or breeding stock) are acquired are known as socioeconomic strategies for reproducing the components of rural production units.

Figure 5 presents an example of the different socioeconomic strategies used by the community of Anccaca to obtain the seed required for the new farming season. The following conclusions can be drawn:

- The lower stratum has less arable land and borrows (from other households) any additional seed needed to start the new crop cycle.

- In contrast, households from the upper stratum possess more arable land and most of their seed for planting is from the previous harvest, or is purchased.

- The middle stratum falls somewhere between the other two insofar as the source of their seed and the availability of arable land are concerned.

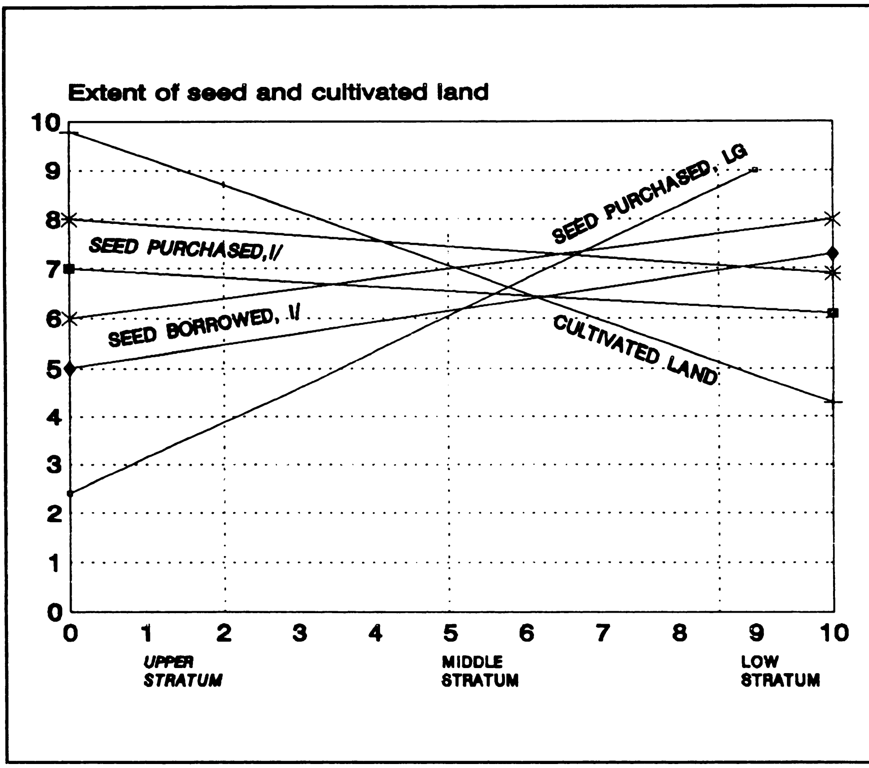


Fig. 5 Origin of seed by social strata, Anccaca 1987-1988.

- Therefore, a program designed to improve seed quality (particularly its shelf life) would benefit mostly those households from the upper stratum, as they tend to store seed in larger quantities.

In short, the socioeconomic reproduction strategies of campesino families entail (1) on-farm storage of inputs; (2) purchase of inputs on the open market; (3) borrowing or reciprocal cooperation mechanisms; (4) migration, whereby inputs are exchanged; and (5) institutional arrangements (for example, the creation of revolving funds).

COSMIC VISION: BASIC CONCEPTUAL MATRIX AND RATIONALE

Research into the rationale of campesino families suggests that they possess a conceptual structure that orients decision-making and determines the choice of a specific agricultural management plan or modulates their relations with the external world (the market, microregions). Following are some suggestions for researching these culturally structured concepts.

Andean households and communities have a specific "vision" that influences their production decisions. This is known as their "cosmic vision," and is understood to mean *that the focus of interest or concept of Andean dwellers is the cosmos (the earth and the stars)*. These concepts are expressed in myths and rituals, in which the relationships between the stars, the earth and crops are symbolically represented (Turner 1980).

Based on this "cosmic vision," Andean dwellers develop a set of technological, socioeconomic and cultural concepts that guide the organization of the production system. Thus, there are concepts such as "totality" (*llapa* in Quechua, *taqui* in Aymara), diversity, security, self-sufficiency, reciprocity, identity, and so forth. These concepts are also applied in the way campesinos use and conserve the ecosystem's natural resources (soil, water, trees, pastures, animals).

The farmers' rationale is reflected in the objectives (not mere desires) that they set out to attain via production, and in the means they use to attain those objectives and goals. Accordingly, in order to comprehend the behavior of campesino families and communities in regard to production, and to propose alternative technologies to them in their function as decision-making units, it is necessary to understand their "cosmic vision" (basic concepts or conceptual matrix) and their rationale (objectives and means of attaining them), as depicted in Fig. 6. Sociological or anthropological research into the ideas and beliefs of the rural population therefore becomes important.

Further, this basic Andean conceptual matrix is not static, but is in a state of constant evolution or flux. Thus, the Andean rural society is continually assimilating new and modern concepts, technologies and expertise through migration, Sunday markets and schools and, primarily, external projects. These new ideas are fused with, and complement, traditional Andean concepts, which are thus modified.

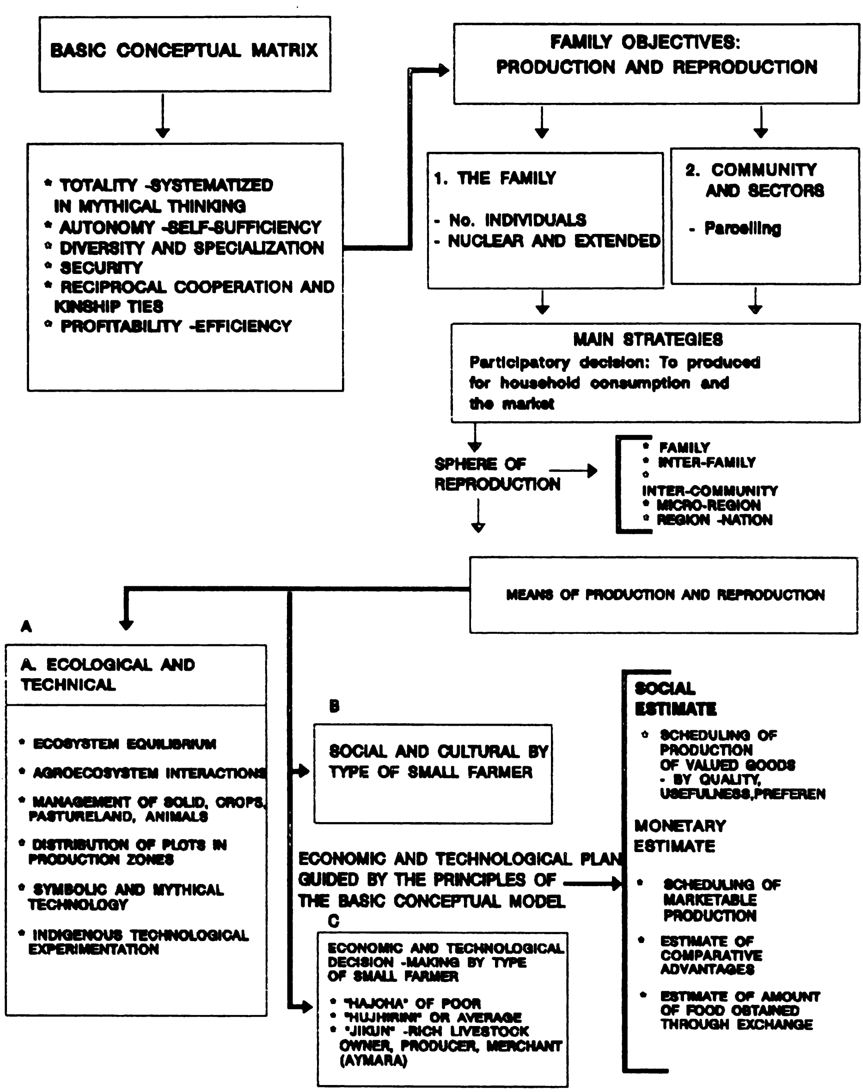


Fig. 6 Conceptual matrix and rationale of Andean small farmers.

In that sense, the new concepts adopted by Andean households are ideas of productivity, earning capacity, profitability and, to some degree, specialization. These ideas are more or less important in the conceptual matrix of Andean families depending on their position in the social hierarchy.

Women play a key role in processing and disseminating these concepts among campesino families, for the following reasons: (1) because they tend to remain in the community and are less likely to emigrate; (2) they are in a better position to observe, and even experiment with (under their own initiative), the adoption of new techniques; and (3) since they spend more time with their children, they have a bigger educational impact on succeeding generations.

The changes in these concepts over time, depending on the social strata, represent a kind of cultural synthesis of what is occurring on the production front. Accordingly, it is important to study the conceptual matrix and the families involved, because they are responsible for plotting the course of technological change.

INTERPRETATION OF FINDINGS: THE CASE OF CAJAMARCA COMMUNITIES

Statistical analyses and choice of variables are justified as long as they match the projects' objectives, and when the latter reflect the objectives and goals of rural households and society as a whole.

For example, the impact of a technological innovation or alternative offered to a community can be analyzed or interpreted according to the following criteria:

- ► The extent to which the innovation in question meets the needs or primary and secondary interests of the campesinos.
- ► The extent to which it meets families' needs in terms of stability and security.

- Whether the technologies adopted generate higher income and, first and foremost, whether they enhance the well-being of the families concerned.

For example, at the Cajamarca Workshop, two field days were organized in the target communities of the Guinea Pig Production Systems Project, with the objective of testing the methods and techniques described in this chapter. The results of this exercise led to the following inferences:

- Regional development in northern Peru is very dynamic, resulting in rapidly growing cities along the coast; this creates a higher demand for guinea pigs (because many of the migrants to the northern coast are from Cajamarca).

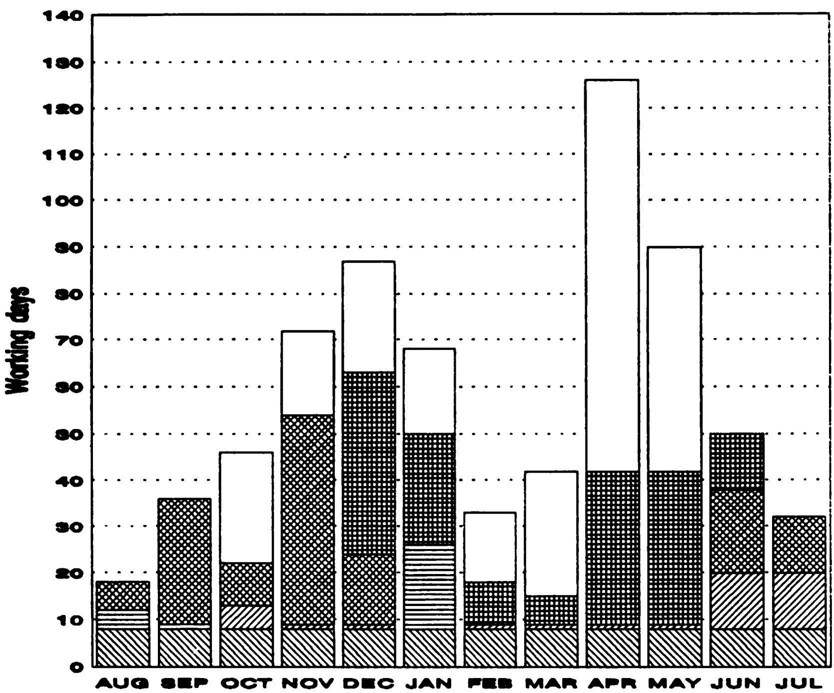
- Upper stratum campesinos in Cajamarca use various mechanisms to expand their production capacity, both by extending the surface area of their potato, maize, alfalfa and other crops and by boosting guinea-pig production with technical assistance from the Project.

- The purpose of guinea-pig production is two-fold: (1) to increase the products available for household consumption and (2) to boost the income of the rural family.

- Guinea-pig producing families from the middle and lower strata improve their diet by including animal protein.

- Analysis of the use of labor within these rural economic systems suggests that a surplus of income and products is required if non-household labor (the hiring of day laborers) is to be invested in guinea-pig production. In other words, when crop production areas are extended and commercial guinea-pig farming is stepped up at the same time, a marketable production surplus is required to cover the wages of non-household workers. A method for calculating household and non-household labor needs during the farming cycle is included in Fig. 7.

It can be said that the Guinea-Pig Production Systems Project is important to the target families because it reflects their primary objectives, and because the technologies proposed can increase family income, thereby enhancing the well-being of these producers and regional society at large.



	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	TOTAL
OCAS	0	0	24	18	24	18	15	27	84	48	0	0	258
POTATO	0	0	0	0	39	24	9	6	33	33	12	0	156
CANIHUA	6	27	9	45	15	0	0	0	0	0	18	12	132
BARLEY	4	1	0	0	0	18	0	0	0	0	0	0	23
QUINUA	0	0	5	1	1	0	1	1	1	1	12	12	35
CATTLE	8	8	8	8	8	8	8	8	8	8	8	8	96
Total	18	36	46	72	87	68	33	42	126	90	50	32	700
Family labour	18	36	46	70	70	68	33	42	70	70	50	32	605
Hired labor	0	0	0	2	17	0	0	0	56	20	0	0	95

Fig. 7 Use of labor in community-based enterprises.

HOW KNOWING THE SOCIOCULTURAL PHENOMENA HELPS PRODUCTION SYSTEMS RESEARCH

Familiarity with the sociocultural subsystem helps researchers understand the following factors:

- The reasons why producers farm in the way that they do.
- The decision-making process of campesinos (what, how much and when to plant).
- The reasons (or rationale) why they manage their agroecosystems as they do.
- The concepts and aims guiding their technological innovation (i.e., their own perspectives).
- The sociocultural constraints and opportunities for the development of technologies adapted to their diversified rationale, not only in terms of ecological niches or agroecological zones, but also by social strata.

In consequence, when a systems approach is adopted, the study of social and cultural variables should be included at every stage: the initial characterization phase, technology generation at experiment stations, research on campesino families, on-farm research, the evaluation of the technology generated (in which the farmers themselves should also play an active role) and the transfer and adoption of technology.

Figure 8 provides a summary of the social and cultural factors involved in technological innovation, according to the specific objective of *achieving a feasible and sustainable technology adoption*. These factors are intertwined, on the one hand, with processes such as *adaptation and* *generation of technology*; and, on the other, with paradigms such as *the basic conceptual matrix*, the producers' rationale, and social phenomena. Figure 8 also contemplates the role of the centers for technology dissemination.

As indicated in Fig. 8, the methodological process for studying the social and cultural potential for technological innovation would consist of the following steps:

- Characterization of the changes involved (whether generated by campesino families themselves or by institutional projects).

- Generation and adaptation of technology, taking into consideration: (1) the differences in producer rationale from one social stratum to another; (2) changes in the inheritance of property and the ways in which those changes either facilitate or discourage the adoption of new technologies; (3) the ebb and flow of migration which favors the introduction of new technological skills into the communities; and (4) the social and technological changes that contribute to the well-being or development of campesino economies.

- Taking into consideration the way those same social and technological changes are assimilated into the basic conceptual matrix of campesinos (e.g., concepts of totality, specialization-diversity).

The dissemination of the information thus generated must consider the following phases: (1) the design, by institutions specializing in technological research, of a model depicting community interrelationships and the actions that may be taken in that context; (2) the consideration of families interested in innovation (not necessarily leaders), those most given to experimentation or regarded as "crazy" by the community; (3) the design of technological alternatives which can then be tested or validated; (4) the incorporation, within a technological demand matrix, of newly validated techniques that are in agreement with the producers' own system and concepts (such as totality, diversity, security) and the recommendation of methods for disseminating the newly validated or adopted techniques.

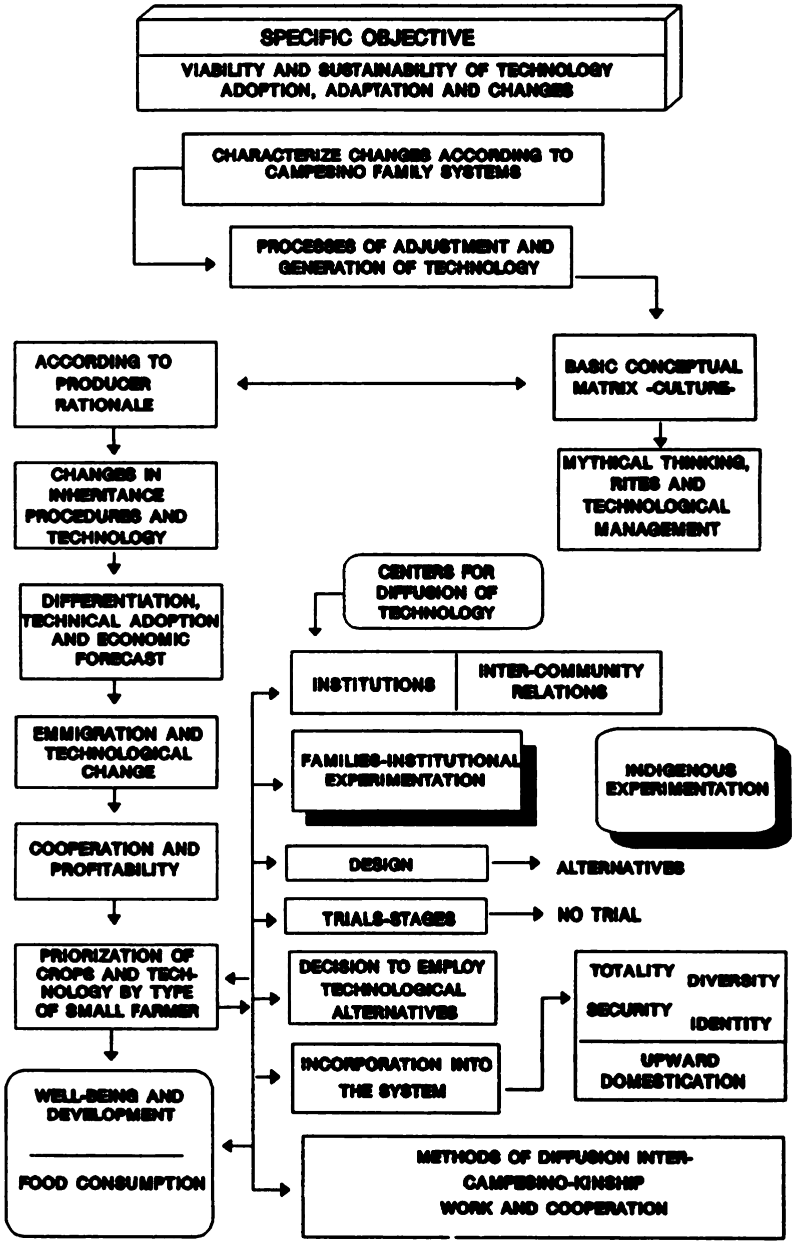


Fig. 8 Social and cultural possibilities of technological innovation.

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METHODOLOGY FOR ECONOMIC ANALYSIS

Víctor Agreda[1]

INTRODUCTION

This chapter examines several economic analyses required for the characterization, evaluation and improvement of small-scale production systems. It also presents methods and recommendations for gathering and organizing the field data required for the various methodological instruments.

As an introduction to the subject, an overview is provided of the most salient characteristics of the production systems managed by small farmers in the Peruvian Andes. Key elements that must be taken into account in economic analysis are highlighted especially the identification and characterization of production systems, their complexity, the multiplicity of tasks performed by family members, and the unique strategies and rationale employed by this particular population.

Two methods of organizing data bases are then presented and described (i.e., the construction of spreadsheets and input-output tables), providing researchers with two instruments for the organization and analysis of field data.

Finally, some economic analysis techniques are described, in particular, those related to the evaluation of total or partial farm yields and the evaluation of technology transfer.

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CHARACTERISTICS OF SMALL FARMERS

The Peruvian Andean farmers with whom the methodological procedures described in this chapter were developed are members of campesino communities, campesino groups, and former cooperatives, whose main economic activity has to do with agricultural production.

They are known generically as small-scale farmers or small landholders, and they and their small farms are, at the same time, units of production and consumption. They also exhibit other characteristics that are worth highlighting for the purposes of this document: their production systems are complex and remarkably heterogeneous (see chapters by Espinosa and Claverías).

In addition to the temporal/spatial arrangement of crops and livestock that farmers have on their own plots, many farmers also enjoy access to communal land. The latter is managed on a rotational basis and is located in *laymis* or *muyuis*, which, though community-owned and controlled, are used by individual farmers. Through town meetings, the community decides which crop(s) is (are) to be planted; which *laymis* is (are) to be worked, exactly when planting will begin, and what will be the harvesting deadline, so that once the cropping cycle is completed the plot can be used as a communal free-grazing area.

The farm household economic activities vary considerably. Farmers are simultaneously croppers, herders, artisans, merchants and, at certain times of the year, local or migrant day laborers. There is considerable complementarity between resources and economic activities.

The various combinations of activities and interactions are responsible for the other characteristic of these production systems that is of particular interest: their heterogeneity. A number of studies conducted in Peru and other parts of Latin America (Murmis 1986; Hopkins and Barrantes 1987; CE&DAP 1990a, 1990b) confirm this through the various typologies and systems they describe.

Any study of the production systems of these farmers should, therefore, take into account the diverse nature of their resources and activities, and their heterogeneity. Traditional instruments of economic analysis, such as studies and estimates of benefit-cost ratios, or those based on specific crop or livestock production units, while important and necessary, are clearly insufficient.

ORGANIZATION AND EVALUATION OF FIELD DATA

The fact that a document dealing with methodological aspects of economic analysis should include a section devoted entirely to the organization of field data warrants an explanation. First, most small farmers do not keep systematic records or accounts. To perform any kind of economic analysis, data must be collected on-farm, either through rapid rural appraisals and interviews or through static and dynamic surveys. This need to collect data is shared by researchers from other academic disciplines. One problem of data collection in the past has been how to organize the data without losing sight of the system as a whole--in other words, how to organize the field data so that all of the information generated by the biological, agricultural and social sciences are used to explain the production systems developed by these farmers.

Secondly, given the nature of these systems and their various components, it is especially important that time be incorporated as a variable in their study, particularly where economic analyses of production flows, non-cash expenses (consumption and barter), labor, income and employment are concerned.

Finally, there is a need for greater clarity in the identification and analysis of the variables and categories based on available field data. These variables and categories will make it possible, at a later stage, to design instruments for measuring such factors as productivity, yield, use of technology, and rate of return on labor, to be used as part of in-depth economic analyses.

A well-known method of starting the analysis and description of production systems uses flow diagrams where the various components and their interactions are shown. Likewise, the diagrams also include the availability of the resources needed for production, such as land, family labor and other household resources (e.g., money, access to communal land) and activities (such as handicraft production or sale of labor). These diagrams are used to identify and quantify flows of all system inputs and outputs. A similar but simpler way of representing a production system was developed by FAO (1980).

In both cases, the objective is not only to represent but also to quantify the production system. This is important where economic analyses are concerned. Flow diagrams have their limitations, particularly at the time of organizing and systematizing the data bases that quantify the different variables, components and flows identified for these production systems.

Presented below, as a complement to flow diagrams, are two analytical instruments for organizing and analyzing field data, based on the results of the most recent work in this field (Hart 1988a; CE&DAP 1990a, 1990b; Quijandría et al. 1990): (1) the building of systems models using spreadsheets, and (2) the construction of input-output tables. These analytical instruments allow researchers to incorporate the farmers' characteristics mentioned in the previous section and, in particular, to systematically reconstruct the various flows peculiar to their production systems. The next section explains the objectives and usefulness of system models using spreadsheets and input-output tables; a more detailed explanation of these two instruments can be found in Quijandría et al. (1990).

Building systems models using spreadsheets

Spreadsheets enable researchers to organize farm data, distinguishing the various activities in which farmers engage, the resources and inputs used and the output obtained, including the output's final use. By way of illustration, in Fig. 1 of this chapter and Tables 1 and 2 of Annex 3 the reader will find examples of how to organize field data on agricultural production by crop and species of animal.

In the case of crop production, the format includes the recording of information on labor, inputs and services used for each management task, as well as the production obtained and the use to which it was put. The data on each crop is aggregated but can be broken down by plot.

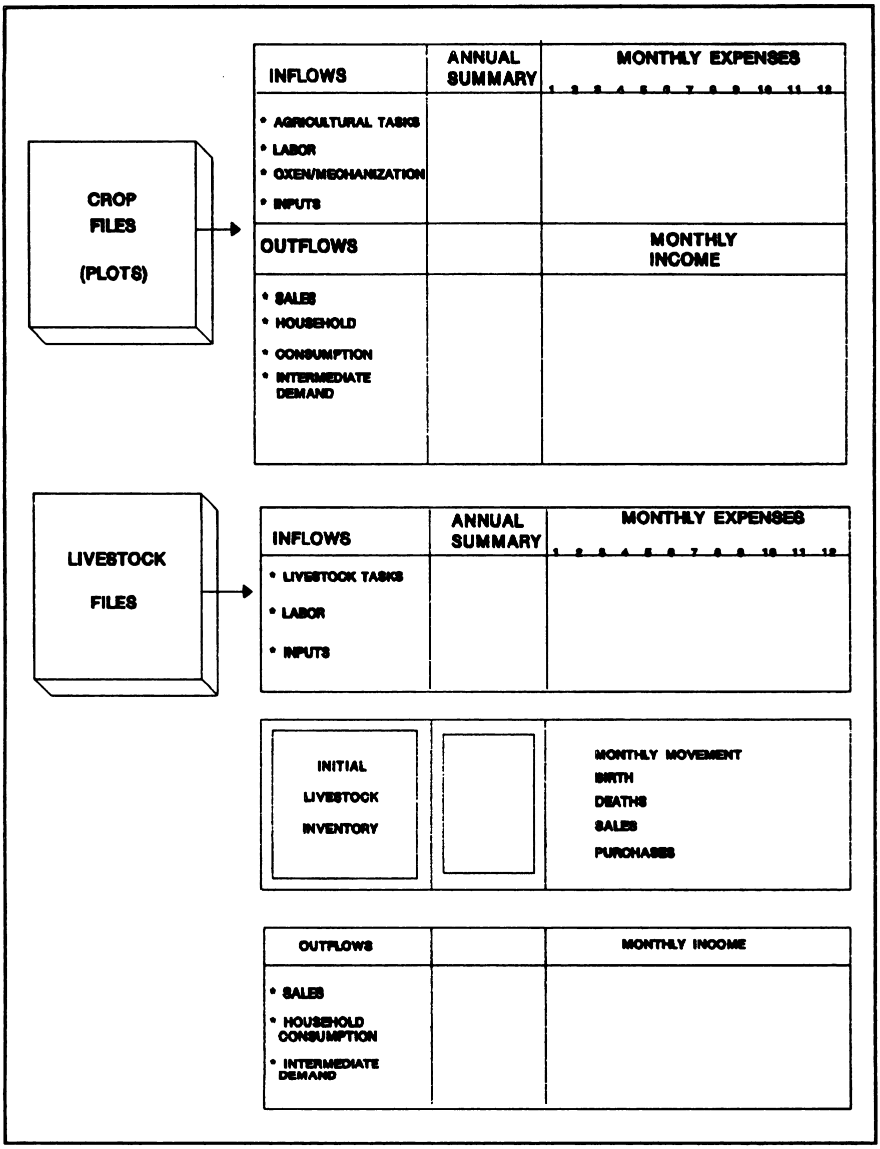

Fig. 1 Structure of files on systems components on computerized spreadsheets.

Source: Quijandría et al. (1990).

This spreadsheet makes it possible to organize data, taking into consideration the distribution of activities and income over time (in this case, by month) for each of the system's inputs and outputs, totaling them for a given period of time, if necessary.

A number of variables have been combined in the formats. For example, in Table 1 (Annex 3) there is no breakdown of the use of labor by category (household, reciprocal or hired). Similarly, no distinction is made between the farmer's own and purchased inputs and services. In other words, there is no breakdown of cash and non-cash expenses, though this is a simple operation using the spreadsheet. In the example shown in Table 1, the aggregation of variables has been done for the sake of simplicity.

Livestock data may be recorded and systematized in the manner shown in Table 2 (Annex 3), which is similar to the previous one. It was designed with the analysis of cattle production in mind, and includes labor as well as inputs and services. It also tracks changes in the herd by category and output, detailing both sales and household consumption. The formats presented are designed to record quantities, as well as prices and costs, thus making it possible to ascertain the values that will subsequently be used in drawing up economic indicators. The difficulties involved in this operation will be discussed later.

The spreadsheets can also be used to record the information regarding other on- and off-farm activities. Using these data, it is possible to undertake an aggregate analysis of the farm and the total economy of the household. The analysis of flows will be discussed later.

By providing a breakdown of crops and/or species of animals, this spreadsheet enables researchers to assess the possible impact of technological changes on production and productivity during the technology validation process. If incremental values on production are included, it also becomes possible to evaluate the impact of increasing levels of inputs (fertilizers, for example) on total yields, income and the benefit-cost ratio.

Individual recording of crops, livestock and other on- and off-farm economic activities can be aggregated to recreate the whole production system under study (Fig. 2). The recent development of advanced computer programs and the increased capacity of personal computers make this aggregation a simple operation, resulting in a simple model for the simulation of the systems concerned. Finally, the aggregated information contained in these spreadsheets can be used to generate the input-output tables presented below.

Input-output table

The input-output table is an analytical tool that allows researchers to systematize field data. This enables them to calculate the system's final aggregate product, as well as intermediate outputs, income and the exchange of goods and services, both within and outside the production system.

In this sense, the input-output table is an analytical instrument for studying the interactions between the different components of each production system. In particular, it is possible to analyze the following factors:

- Inputs or primary factors. In other words, those whose supply, in the period covered by the analysis, does not depend on the activities described in the table; for example, natural resources, capital and labor. These factors are regarded as constant during the period in which the functioning of the production system is analyzed, but can be modified for future periods.
- Production flows.
- The exchange of goods and services between the various activities or components of the system and between it and the outside world.
- The overall demand for goods and services; that is, consumption, investment and exports (sales).

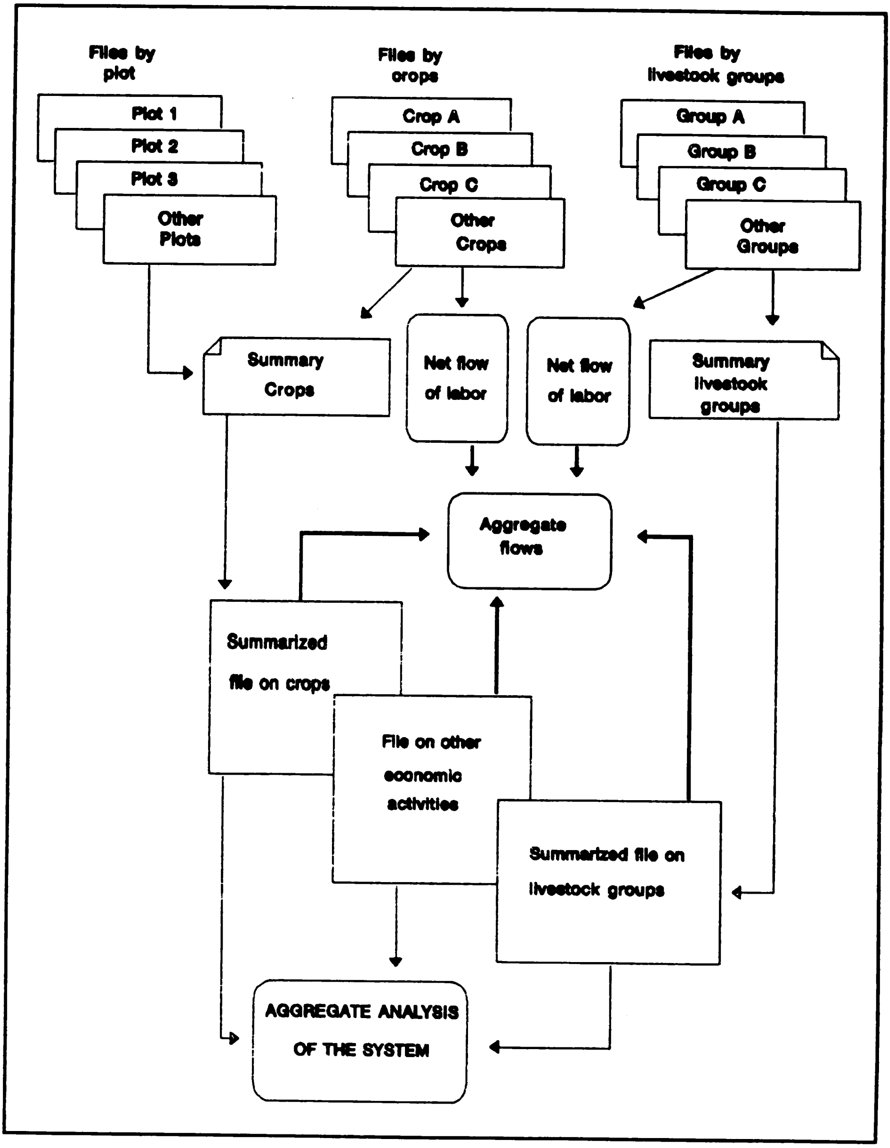

Fig. 2 Structure of files on computerized spreadsheets aggregated at the systems level.

Source: Quijandría et al (1990).

Table 1 shows the way in which the above-mentioned variables are presented to describe a production system based on the input-output model.

Table 1. Table of inter-activity flows[1]

ACTIVITIES	1	2	3	4	5	6	
	(C)	(L)	(G)	Cn	Iv	Xp	Total
Crops (C)	X_{11}	X_{12}	X_{13}	D_{14}	D_{15}	D_{16}	X_1
Livestock (L)	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	X_{26}	X_2
Goods (G)	X_{31}	X_{32}	X_{33}	X_{34}	D_{35}	D_{36}	X_3
Imports (I)	F_{i1}	F_{i2}	F_{i3}	D_{i4}	D_{i5}	---	X_i
Work (W)	F_{w1}	F_{w2}	F_{w3}	---	---	---	X_w
Capital (K)	F_{k1}	F_{k2}	F_{k3}	---	---	---	X_k

1 The example given refers to a household economic unit (HEU) whose production system is characterized by the following:

- It has three productive sectors:
  Production of crops (C)
  Production of animals (L)
  Production of goods (G)
- For carrying out its activity, it has three factors at its disposal; two are primary in nature (resources that cannot be reproduced during the period under analysis), and the imports. Accordingly, the resources will be:
  Imports (I)
  Work (W)
  Capital (K)
- The final output of the different activities is used for consumption (Cn), investment (Iv) and sales or exports (Xp).

Explanation of the rows in the input-output table

The first three rows refer to the production of crops, livestock and goods (G) obtained in a single year. X_1 represents total crop production; part of this production is used as a crop input (e.g., seed) (X_{11}), a livestock input (X_{12}), and for the production of value-added products (X_{13}). The rest goes to meet the final demand, in other words, consumption (D_{14}), increases in capital (D_{15}) and sales/exchange (D_{16}) (exports). The second line shows the total production generated by livestock activity (X_2) and the use to which it is put, either as an input for crop production (X_{21}) and the generation of goods (X_{23}) or to meet the demand for consumption, investment or sale (D_{24}, D_{25}, D_{26}).

The third line indicates the overall production of goods derived from agricultural activity (X_3) and the use to which they are put, either as inputs for crop or livestock production (X_{31}, X_{32}) or to satisfy overall demand (D_{34}, D_{35}, D_{36}).

The fourth line shows total imports X_i, their allocation to activities F_{i1}, F_{i2}, F_{i3}, and to the overall demand D_{i4} and D_{i5}. The last two lines represent the labor resource measured in person-days or person-hours per year, and the available stock of capital measured in terms of the utilization period and its allocation to the different production sectors.

The income created by the use of capital and labor resources, less capital depreciation, is the income generated by the system. A quick examination of Table 1 will show that, if all flows are given a monetary value, the value of the income is equal to the total value of the overall demand matrix, minus the value of the imports and capital depreciation.

Explanation of columns

The first three columns represent the technological processes used by the household economic unit (HEU). Each column indicates which resources and factors are required, and in what proportion, to obtain a given amount of output; in other words, production is a function of the intermediate inputs and primary factors involved.

For example, crop production requires:

$$X_1 = F_c\,(X_{11}, X_{21}, X_{31}, F_{i1}\ F_{w1}, F_{k1})$$

These expressions therefore represent situations in the production functions; that is, in order to produce a given level of output (e.g., X_1) specific levels of inputs (X_{11}, X_{21},.... etc.) are required. Based on these expressions, it is possible to ascertain--for each activity, crop or livestock--the proportions of factors and inputs needed to obtain a single unit of output.

Furthermore, it becomes possible to determine the requirements of any level of production when it is assumed (1) that these coefficients do not change during the period under analysis, (2) that the yields of the production functions are proportionate to the level of inputs used (in other words, if all the inputs increase or decrease in the same proportion, the output will vary by that same amount), and (3) that the farmer is always trying to keep the use of inputs to a minimum. These production requirements are of two types: those that can be regenerated by the farmer and those that cannot; the latter, in many instances, actually become limiting factors.

To resume, the input-output table is an analytical tool that allows the researcher to systematically organize the flows of goods and services produced by campesino families over a given time period. As well as organizing the information, the table makes it possible to perform an integrated analysis of field data, taking into consideration the complementarity between the different activities and the primary resources used. Lastly, more precise economic indicators--such as net income--can be developed, and other research topics addressed (while building the table)--such as the extent and nature of the farmer-market interaction, the technologies employed, household consumption and its sources, and household cash income and its makeup.

Generation of economic indicators using the table

With the farm data thus arranged, the following economic indicators can be generated:

- Total gross production (TGP): This is equal to the sum of the value of intermediate demand (C + L + G in the matrix column), plus the value of the production earmarked for household consumption, investment and sale.

  TGP = (C + L + G) + Cn + Iv + Xp

  where:

  Cn = Household consumption
  Iv t= Investment
  Xp = Sale

- Net production (NP): This is equal to total gross production less the production earmarked to satisfy the intermediate demand.

  NP = TGP - (C + L + G)

- Net income less A (NI - A): This is equal to net production plus the income received from temporary migration and sale of household labor locally plus rental income received from the use of production means (oxen, tractor, animal transportation), minus the value of imports destined to support agricultural and livestock activities.

  NI - A = NP + SL + ISP - ICL

  where:

  SL = Sale of labor locally and income from migration
  ISP = Income from services provided (oxen, tractor, etc.)
  ICL = Imports for crop and livestock activities

The above economic indicators enable researchers to estimate net income and its sources with greater accuracy. The greater the follow-up of the diverse economic activities in which the farmers engage, the more reliable the estimate will be.

Furthermore, on the strength of these indicators, which are the result and expression of productivity, it is possible to calculate other indicators involving stocks of resources, such as the relationships listed below:

- Net agronomic income/agronomic labor expenditure
- Net livestock income/livestock labor expenditure
- Total net income/total labor expenditure
- Net agronomic income/hectares cultivated
- Net livestock income/number of animal units
- Man-days employed in cropping/hectares cultivated (ratio A)
- Net agronomic income/A
- Man-days used in livestock/number of animal units (ratio B)
- Net livestock income/B

These indicators could be used to make comparisons between farmers--for example, by type, region or community. These comparisons would provide extremely useful, high-quality inputs when evaluating the economic impact of the technologies promoted by projects.

Limitations of the instruments presented

What are the drawbacks of the two instruments presented above insofar as the analysis of small-scale farming systems is concerned?

The reliability of economic indicators or of any analysis based on spreadsheet-models and input-output tables, will depend on limitations other than the quality of available data. These limitations arise from the difficulties in properly representing, in spreadsheets and tables, the real economic behavior and situations characteristic of small farming systems, particularly those from the poorest and most proletarized economies, such as those located in the mountain regions of southern Peru.

Analytical accuracy will be further reduced if the cash component, as a proportion of production and income, becomes smaller. Also, it must be borne in mind that precision in analysis will also be affected by attributing values to flows of goods and services, which do not participate in the market economy in the same manner as products do.

In addition to the limitations indicated above, there are also problems associated with the time frame of the analysis. The choice of a calendar year or farming year is arbitrary at best and can lead to errors in the analysis of production systems, as the year may be an unusual one or may form part of climatic cycles spread over several years, or may be influenced by incidental economic problems (Quijandría et al. 1990).

ECONOMIC ANALYSIS AT THE FARM LEVEL

This section presents various alternatives for performing economic analyses using the production systems approach; in particular, those that entail the characterization of production systems and the evaluation of technology transfer processes.

Use of economic analyses for the diagnosis and characterization of production systems

The aim of the diagnosis and characterization carried out under the systems approach is to identify and describe the prevailing production systems and to determine the main exogenous and endogenous constraints to agricultural production. This identification and characterization takes account of social, economic and biological factors. In addition, this stage attempts to determine the so-called *homogeneous production regions or recommendation domains* through analysis of the ecological, social and economic characteristics of the regions where projects are located.

What does economic analysis contribute to the characterization of production systems at the farm level?

As was evident from the presentation of spreadsheets and the input-output table, economic analyses make it possible to identify the most important flows within the production systems--that is, the particular way in which farmers allocate their resources and obtain a specific level of production and income. In doing so they use specific technologies, interact with other farmers and establish links with the rest of the economy through diverse markets.

Therefore, on the strength of these two instruments of analysis it is possible to obtain the following information for each farmer, type of farmer, community and region:

- ▸ The destination of the crops produced
- ▸ The destination of the livestock produced
- ▸ The destination of the goods produced
- ▸ The relative weight that each activity has in the production process and in the generation of net income
- ▸ The breakdown of the operational costs involved in cropping
- ▸ The breakdown of the operational costs involved in livestock production
- ▸ The cash income generated by each activity

Types of farmers

Before moving on to analyze the most important flows within the production systems from an economic standpoint, the contribution made by economic analyses to the characterization of production systems, based on the relative importance of the sources of income, will be examined.

It has already been mentioned that one of the salient characteristics of small farmers is their marked heterogeneity. However, at least in the case of Peru, studies of production systems carried out by researchers from the agronomic sciences, particularly studies of components and their combinations, are insufficient to determine the differences that exist between farmers, unless agroecological differences are included. Only when elements such as economic variables are included, particularly with reference to sources of income, do the differences between farmers from the same area become clearly identifiable.

Two examples will help to clarify the above concepts. The first involves a study carried out in Cajamarca, in the district of Namora (Agreda et al. 1988), which set out to identify types of farmers by using multivariate analytical techniques. Mixed production systems are the norm in this region, and the characteristics of the farms were very similar. This was particularly true of the composition of the household, land tenure and livestock, the educational level, patterns of land use, technology employed, and so forth. The only differences in the systems prevalent in this region were those due to the differences between the region's two main agroecological zones. The only way of differentiating between farmers was to use variables such as the relative weight of the different components of income as a proportion of total income.

Something similar occurs in the alpaca production systems of the Andean high plateau region, where there is virtually only one production system. Here the possibilities of alpaca production systems evolving in different ways are more restricted than in Cajamarca due to the more uniform agroecological environment, although differences between farmers were detected in terms of their access to *bofedales* (marshlands or pasturelands with permanent standing water). Nonetheless, remarkable differences between farmers can be found in terms of the diversity of the sources of income at their disposal and of the markets in which they participate.

In other words, the differences in farmers' sources of income, and not the particular way in which they organize their systems, is the variable that accounts for the existence of different types of farmers.

Analysis of production, employment and income flows

Based on production data organized in computerized spreadsheets, it is possible to conduct a dynamic economic analysis of the most important flows occurring in production systems over time. This can be done by studying the various flows concerning production, labor, expenditure, income and, lastly, cash availability. The analysis must use farm data collected in a dynamic survey and organized in a spreadsheet, discriminating the various types of farmers.

Flow analysis permits the conduction of in-depth assessments of resource allocation (mainly labor and expenditure), and the identification of the main constraints that obstruct farmers' efforts to attain their objectives.

The monthly changes in farmers' income and expenditures, on the other hand, enable researchers to understand the specific configuration resulting from the combination of production factors for each type of farmer; this, in turn, determines the working capital requirements for the productive cycle. In other words, the monitoring of these changes makes it possible to identify the various points in time at which the farmer decides what, how, how much and for whom he should produce. In addition, researchers are able to calculate the economic results of the gamut of activities undertaken by farmers and their families over a given period of time.

For the purposes of illustration, flow diagrams for individual factors are presented below; the specifics of these will vary according to the production systems under analysis.

Figure 3 (and Table 3 of Annex 3) present formats for what would be the analysis of total labor flows for livestock activities for a single production cycle. For the purposes of simplification, the different types of labor have been aggregated and standardized using as the unit the man-day. The aim is to analyze the monthly labor requirements for livestock production.

It is perfectly feasible to break down labor requirements according to each type of activity, and even for each family member. For example, researchers from disciplines such as sociology and anthropology may be interested in analyzing the different relationships that specific farmers establish with their peers in order to obtain labor at certain peak demand periods in the cropping season or in the livestock calendar; or they may want to study the extent of different family members' participation in production activities, as well as the particular responsibilities they assume.

Examples of the analysis of cash flows are presented in Fig. 4 (for both crop and livestock activities) and in Table 4 of Annex 3 (for livestock activities only).

For each activity, the cash income received by the farmer is identified, as well as the most important items of production-related cash expenditure. The monthly and accrued balance per activity can then be determined.

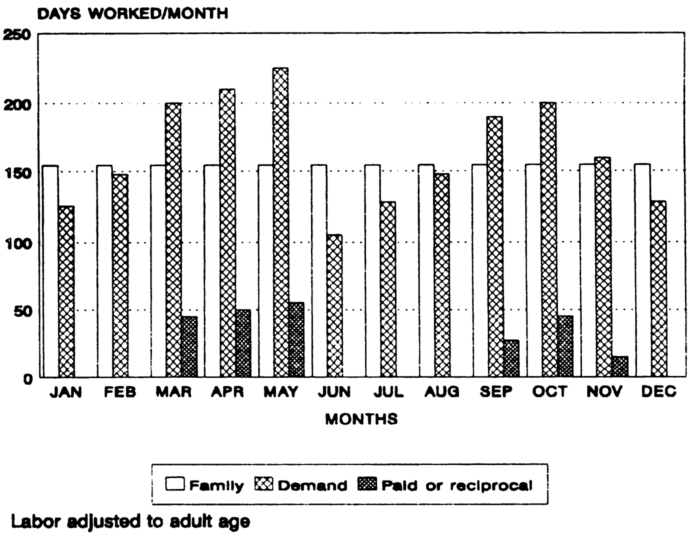

Fig. 3 Annual flow of labor aggregated at the system level.
Source: Quijandría et al. (1990).

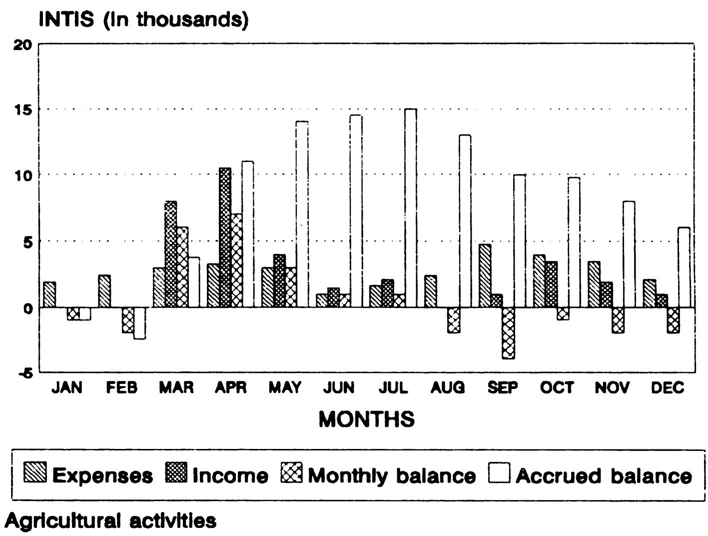

Fig. 4 Cash flow aggregated at the farm level
Source: Quijandría et al. (1990).

ECONOMIC ANALYSIS OF TECHNOLOGICAL OPTIONS

This section presents several analytical instruments that can be extremely useful in evaluating the technical changes promoted by research and development projects; the instruments described are designed to resolve four specific problems:

- Problems regarding the evaluation and selection of technologies when the researcher lacks sufficient field data. *Ex-ante* evaluation techniques will be useful in these cases (see following subheading).

- Problems related to the validation of trials and experiments through partial-budget analysis.

- Problems related to the validation of technologies, taking into consideration the risk and uncertainty involved.

- Problems related to the validation of the economic impact made by the technologies being promoted among farmers.

Rather than presenting new instruments, the purpose here is to highlight the feasibility of using different existing instruments to address the problems identified, while recognizing their power and limitations. The instruments used to address the problems are presented below.

Instruments for the *ex-ante* evaluation of technologies

Systems researchers are usually obliged to evaluate given technologies on the strength of very limited field data, with reference to only the information garnered from trials conducted on experiment stations. Another common practice is the attempt to evaluate the impact of a technology whose advantages will only become apparent a number of years after implementation. This is the case, for example, of evaluations of the introduction of a given tree or animal species.

To address these problems, the researcher can take advantage of two instruments widely used for the evaluation of investment projects. These are net present value (NPV) and the internal rate of return (IRR).

Net present value

NPV is a measure of the updated value of an investment; in the case of technology evaluation, it is the current value of the incremental net benefit or incremental cash flow stream of funds generated by a technology (Gittinger 1980).

The process of finding the net present value of future income is called "discounting." The interest rate assumed for discounting is the "discount rate." The net present value can be formally expressed as follows:

$$NPV = \frac{B_t - C_t}{(1 + d)_t}, \quad t = 1,2 \ldots n$$

where:

B_t = benefits in year t
C_t = costs in year t
d = discount rate in year t
n = number of years
t = a specific year

In principle, the discount rate should reflect the rate of return that the farmer could have obtained had he invested his capital in another activity--in other words, the opportunity cost. There is no difference between the discount rate and the interest rate; the only difference is the point of view: The interest rate assumes looking from the present to the future, while discount rate looks backward from the future to the present.

The NPV is very useful for comparing the benefits of two technologies (e.g., the "improved" technology versus the farmer's traditional technology) over a given time-period, if, for example, present-day costs and benefits per hectare are calculated. The costs comprise expenditures on day laborers, inputs and so on, while the benefits include items such as expected income (quantities times price) for each year. The value for each year is calculated, and to this is added the present value calculated on the basis of the discount rate. If the NPV is greater than zero, or greater than that of the farmer's own technology, then the alternative is viable.

Thus, the NPV is very useful because it allows researchers to address situations such as the following:

- Higher yields of a given crop in a specific year. In other words, it can be assumed that the proposed technology will produce higher returns as of a specific year, so it will not be necessary to assume a constant rate of return.

- Higher initial production costs. Improved technologies nearly always call for larger outlays during the first years of implementation, which may decrease as the years pass.

- Collateral benefits of the proposed technology that may become discernible at some point in time.

The limitations of this instrument, in terms of the evaluation of technologies targeted at small-scale farmers, can be summed up as follows:

- First, there is the problem of choosing the appropriate discount rate. If it is already difficult to determine the opportunity cost of capital for a given country, it will obviously be even harder to do so under the conditions in which small-scale farmers operate (where there is no developed capital market).

  One alternative is to use the current rate of interest in the financial system instead of the discount rate, but even this can be a problem; in countries like Peru, access to formal credit is very limited, particularly where small-scale farmers are concerned.

  On the other hand, the rate of interest being charged in the informal market (to which many small farmers must resort) may be considerably higher, thus making it very difficult to determine the true cost of capital without underestimating it.

- The other limitation concerns the risks and uncertainty farmers face in production and marketing. Indeed, NPV assumes that farmers are impervious to risk or that risk is not an important factor in the equation. In fact, it is a given that, in opting for a specific technology, farmers are mindful of the inherent risks and the resources that will have to be invested. Accordingly, they may not be prepared to try out technologies that hold out the promise of higher yields, but also entail greater risk.

Internal rate of return (IRR)

One alternative to NPV is the calculation of the IRR, which is the discount rate that makes NPV (that is, the net present value of the incremental net benefit stream or incremental cash flow of funds) equal zero.

The IRR can be expressed as follows:

$$IRR = \frac{B_t - C_t}{(1 + i)_t} = 0, t = 1,2 \ldots n$$

where:

B_t = benefits in year t
C_t = costs in year t
i = interest rate
n = number of years

The formal selection criterion would be to accept all those whose i value is equal to, or greater than, the opportunity cost of capital. However, when considering mutually exclusive technologies (just as is the case for investment projects) comparing only IRRs can result in the wrong technology being chosen. In such cases, NPV can be very useful.

The soundness of the choice depends on how reliable the estimate of the opportunity cost of capital is thought to be. In other words, a specific technology should not be chosen with any degree of confidence on the strength of the IRR alone, as this will only indicate in very general terms that one technology is better than another because it generates more income in relation to the resources used. But, whatever the IRR value, it must be compared with the opportunity cost of capital which, in the final analysis, is the formal criterion for making decisions.

Dominance and sensitivity analyses

Dominance analysis and sensitivity analysis are two very useful instruments for comparing various technological options particularly when market conditions are taken into account.

Analysis of dominance enables researchers to select--from among various technological options--those options that guarantee a maximum net benefit for different levels of capital investment. It is also possible, by comparing the variable costs and the average net benefit obtained for each technological option, to eliminate those that are economically inferior--that is, those technologies with higher variable costs and smaller returns.

On the strength of this analysis, it is possible to construct a net benefit curve based on the economically superior technologies that defines the maximum possible returns for different levels of capital investment.

The sensitivity analysis is an analytical method for systematically testing what will happen to the rate of return of a technological option if the events turn out differently from what was expected. Strictly speaking, it offers a means of addressing the problem of uncertainty with regard to future events and price indexes.

A sensitivity analysis is performed by varying one factor or a combination of factors, and then determining the impact of that change on the eventual outcome. Thus, once the economically advantageous technological options have been identified, they are then tested against possible conditions that they are likely to face in the market: a fall in the price of the final good, a hike in variable costs due to higher input prices, among others; and, based on this exercise, researchers can analyze the effect of these changes on market conditions and on the profitability of the alternatives involved (JUNAC 1986).

The data required for these analyses is the same as for the partial budget (which will be examined below), plus information on the evolution of variable costs and price indexes.

Instruments for the *ex-post* evaluation of technologies

Ex-post evaluation is a critical analysis of the accomplishments and results achieved by projects in their different areas of action (research, extension, training, development) in relation to the objectives set, the basic hypotheses and strategies employed, and their utilization of resources.

The evaluation is a process whereby the suitability of what was proposed can be compared retrospectively with what was actually executed, taking into consideration how, why and for whom it was done. Likewise, this process identifies the reasons for both satisfactory and unsatisfactory results. This evaluation also produces findings that will have a bearing on future activities or other activities currently underway.

Ex-post evaluation is mainly suitable (1) for operational purposes, to verify achievements; (2) as an analytical tool that contributes to the improvement of new proposals, in both their design and their methodologies; and (3) for policy-making purposes, to confirm the soundness of a given strategy or approach. In addition, such evaluation leads to the identification of technologies that require more field tests and adjustments, proven technologies that can safely be recommended, and important breakthroughs that can be used to design new policies.

The research process must reach the farmers who are to use and implement its findings. The identification, by means of *ex-post* evaluation, of technologies that are ready for dissemination is, therefore, an important step in catalyzing this process. The most important benefit of this type of evaluation is that it facilitates the identification of areas for subsequent studies and activities that are more useful to the clients concerned.

On the other hand, as part of this process, impact studies go further and analyze the level and distribution of benefits. A complete and thorough examination of the results and their consequences is necessary; in the absence of this analysis, it is not possible to assess the real or likely impact of a new technology.

A full *ex-post* evaluation should encompass the following aspects:

- An inventory of the technological outputs of the project
- Economic analysis of these same outputs
- Analysis of the project's socioeconomic environment
- Analysis of government policies (macro and sectorial) related to the project activities
- Analysis of the processes of technology generation, transfer and adoption
- Estimation of the project's benefit-cost flow and the internal rate of return
- Analysis of the distribution of the benefits generated
- Analysis of the project's indirect or non-quantifiable benefits

With the above in mind, and for the purposes of this document, two types of *ex-post* evaluation are discussed below: (1) validation of trials and experiments and (2) validation of impact at the farmer level; each is explained, with emphasis on the objectives in each case, the possible instruments that can be used, and the data required.

Validation trials and experiments. One of the most important project activities is the on-station and on-farm validation of technologies by means of trials and experiments. However, two problems may arise:

- Verification whether the technology recommended for the farmer is superior (from both the agronomic and economic standpoint) to the one traditionally practiced, once the new technology has been implemented for more than one farming year.

- Selection, from among the technologies proposed, of the one that is most efficient--in other words, the one that enables the farmer to obtain higher levels of production and income for the same amount of resources or less.

The instruments of economic analysis used to validate trials and experiments are well established and widely documented in handbooks on technology validation. Only an overview will be provided here.

Partial-budget and benefit-cost analyses

The partial-budget analysis is a simple method of economic analysis which compares the variations in costs and gains offered by the various alternatives. It has the advantage of not requiring data on all the production costs and returns, but only those that change when farmers exhange their traditional practices for the new technological options to be evaluated (Horton 1981).

The costs associated with the decision on whether or not to adopt a new technology are known as the *variable costs*, while the components not affected by this decision are known as the *fixed costs*. The latter are not a factor in the decision to adopt the technology because they will be incurred in any event.

The above is usually expressed as follows:

$$NI = TI - VC$$

where:

NI = net income
TI = total income
VC = variable costs

In other words, the change in net income is the difference between the change in total income and the change in the variable costs.

Based on the concept of net income increments, benefit-cost is defined as the ratio between the change in the net benefit and the change in the cost of the variable factors at the farmer level. In other words, the benefit-cost ratio measures the return on each additional currency unit that is worth investing in a new technological option.

For a technological option to have an economic advantage over the farmer's own technology, the change in net income must be positive. Unless the increase in net income is substantial, the farmers will not be prepared to adopt the new technology. If the proposed technology is more expensive than the farmer's own, the rate of return must also be at least as high as those of the other investment opportunities available to the farmer (i.e., the opportunity cost), and high enough to offset the risks involved in its adoption.

To perform benefit-cost analysis, field data is required (test plots, dynamic surveys of farmers), as well as the careful recording of all the variables (both income- and cost-related) that will be helpful in assessing differences between technologies.

Analysis of minimum return

There are different techniques for analyzing the risk factor, such as the calculation of variations in yields, minimum returns, the function of loss, potential loss, among others.

For small-scale farmers operating barely above the subsistence level, the most relevant aspect is probably the risk of income dropping below that level. For this reason, small-scale farmers tend to be relatively conservative in their technological decisions. They prefer the relative security of a small but constant income (using a technology that results in low production but entails little risk) to a technology that promises increasing yields, but at a greater risk.

The analysis of minimum return, taking into consideration the farmers' aversion to risk, highlights what would happen in the worst-case scenario, such as a natural disaster. The lowest yields (for example, the lowest 25% of the yield distribution for each treatment) are taken from all the test sites available and are compared. This comparison will give the researcher an idea of the relative risk of disaster under different treatments.

The advantage offered by this analytical instrument in evaluating the risk factor is that it does not call for sophisticated calculations, but rather, for numerous repetitions in both time and space. The data required is the same as for the partial-budget analysis.

Budget analysis considering risk and uncertainty

When the risk factor and uncertainty faced by the farmer are critical to an understanding of the farmer's decision-making process and, therefore, of his/her decision to adopt or reject a given technology, one alternative is to draw up a risk budget.

Budgets of this kind take account of the distribution of probabilities for the least predictable variables, such as yields and prices, with the aim of evaluating the probability distribution of benefits obtained under various scenarios. For example, income per unit area of a given crop can be expressed as follows:

$$G = Y (P - U) - V$$

where:

G = gross income (US$/ha)
Y = yield (kg/ha)
P = is the price (US$/kg)
U = variable expenditure related to the level of yield
V = variable expenditure not related to the level of yield

In this case, both yield and prices are unpredictable and it would be appropriate to analyze the probability distribution of these variables. The risk budget refers to the use of these distributions in tandem with the calculation of U and V to arrive at the probability distribution of the gross income (FAO 1980).

The Montecarlo method can be used to calculate the probability distribution of the gross income. This estimates probabilities and expected gains (or costs) through the empirical sampling of processes or probability distributions (Spurr and Bonini 1986).

Given that the state variables (in this case, prices and yields) are unpredictable, the producer has no control over them. To measure their sensitivity, all variables are given a nominal value (baseline scenario), and the variables under analysis are attributed values using triangular distributions (the maximum value possible, the minimum value possible, and the most probable or modal value). Critical variables--in other words, those that have the greatest impact on gross income and are regarded as random variables--are then identified.

The next step is to determine a probability distribution for the random variables by drawing up a decision tree, for which it is necessary to assign probabilities to each of the random variables. It should be pointed out that the attribution of probability does not mean that the best alternative will automatically be identified. To do this, researchers must also assess the farmer's aversion to risk, which can be represented by a profit curve; only then can the best technological option be selected: that which maximizes the expected average profitability and minimizes the expected loss.

Validation of economic impact at the farmer level. This section outlines the procedure for conducting an economic analysis aimed at identifying the technical change brought about by projects and evaluating the impact of this change on productivity, resource allocation, and farmers' income.

First, the technical change that has taken place among the project's immediate clients (farmers) must be assessed, taking as its point of reference the production level at the moment when the project began, including data for the families that did not take part. In addition, researchers need to know which variables best explain the technical change; this will facilitate the evaluation of the effectiveness of each of the innovations contained in the technology package designed by the project.

Then, the impact of and interrelationships between the different variables contained in the technology package (crop association/rotation, improved seeds, introduction of crops for agroforestry, combination of organic and chemical fertilizers, pesticides, and so forth), and those variables related to production (land and labor productivity) and income are determined.

Validation of impact at the farmer level measures the extent to which the recommendations made were adopted by farmers participating in the project. In other words, it estimates the relative participation of families adopting all the technological recommendations in relation to the total number of families, and it explains their reasons for doing so. For the purposes of this analysis, explanatory variables are taken to be any differences between families in terms of the availability of and access to productive resources and the difficulties they face in appropriating economic surpluses associated with the technical change.

The following hypothesis is used to determine the impact on farmers' productivity and income: If the project had not been implemented, the agricultural practices of the immediate client families would have been the same as those recorded at the outset of the project, or similar to those of the households that did not take part (Chahuares 1978).

The data obtained from the characterization of farm production systems--even though in most cases this is not complete at the time the rapid rural appraisal is carried out--enable researchers to define the characteristics of the agricultural and forestry practices employed at the start of the project. The farm data generated for the last farming year makes it possible to perform a comparative analysis of two moments in time.

It is assumed that the initial agricultural practices of participating families at the start of the project are similar to those still used by the families which did not take part. This provides two types of comparisons: one at different times and the other at different locations. Thus, any differences detected in agricultural and agroforestry practices and in the impact of these differences on production and income are the result of the technical change promoted by the project.

The unit of analysis is the farm household. For the purposes of evaluation, these households are classified according to their degree of involvement in the project as detailed below:

- Direct client farm households. These are defined as those families that are served directly by the project.

- Indirect client farm households. Those which fall within the project's sphere of action but are not served directly thereby.

- Non-client farm households. These are outside the project's immediate sphere of action (but not outside the region), present similar characteristics insofar as their pool of resources and production and barter conditions are concerned, but do not form (and never have been) an integral part of any rural development project.

Multivariate analysis makes it possible to identify the technical change and the relationship between technological and production variables. In contrast, single-variable analysis of variance is suitable to tasks such as the detection of significant statistical differences between types of farmers (as determined by cluster analysis)--for example, whether there are differences between those farmers linked and not linked to the project with respect to the intensity of the use of an input or the rules governing barter of goods.

Discriminant analysis is necessary to evaluate the adoption of recommendations by farm households according to the strata they belong to--in other words, this technique serves the purpose of evaluating the scope of the project and its limitations. Limitations, for example, can be explained by variables such as the differences in the availability of, and access to, production resources, as well as the conditions regulating their trade-off.

Lastly, component analysis helps identify the most important variables in the technological spectrum of each stratum of farm households, and their relevance to production and income.

The farm data required for these types of analyses are generated by the dynamic survey of a group of participating farmers; this survey can be complemented with a static survey of a randomly selected sample of farmers not involved in the project's activities.

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INTEGRATION OF SOCIAL ANALYSIS METHODOLOGIES INTO PRODUCTION SYSTEMS RESEARCH

Benjamín Quijandría[1]

In its early days, production systems research was conducted by professionals from the biological sciences. After many diagnostic studies and much field work, it became clear that the successful generation of technology called for clear insight into farmers' objectives and views, as well as an understanding of the economic dynamics of the many activities in which they engage, both on and off the farm.

In recent years, have seen a growing interest in the role of the social sciences in farming systems research and technology transfer, in order to better understand small farmers' technical and productive views, and to develop guidelines for technology generation consistent with their ecological and socioeconomic conditions (Rhoades 1983b; Horton 1984; Espinosa 1986). This interest is shared by international research centers, networks and field projects.

Early social research (Horton 1984), applying empirical analyses to the campesino context and attitude toward technological change, has made it possible to define six aspects of particular importance:

- The agroecological environment and type of farm directly condition technological requirements and needs of farmers.
- Campesinos, small farmers and village dwellers are receptive to change and new technology.
- The process of adopting technologies entails the partial introduction of technology packages, with producers selecting the components that best fit their needs.

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- Studies to date suggest that the technology used by small farmers is, in many cases, equal or superior to practices recommended by external projects and programs.

- The necessary expertise exists to solve many production problems/constraints faced by farmers.

- The technology generated cannot be transferred unless it is adapted to local conditions.

Horton's conclusions (1984) have been confirmed by researchers from the International Potato Center (CIP) (Werge 1979; Rhoades and Booth 1982; Rhoades 1982, 1983a, 1983b) and numerous research projects that met with severe limitations in technology adoption processes. While it is true that certain general concepts regarding participation of the social sciences in production systems research at the farm level have been defined (Espinosa 1986; Ruiz 1994), project directors and coordinators--specialists from the biological sciences--still have questions as to how social research should be coordinated to complement work in the agronomic and zootechnical fields.

Social studies with a production systems approach have been conducted in the Andean region, where the prevailing agroecological and socioeconomic conditions have given rise to extremely complex production systems. On the other hand, projects located in agroecological regions or countries with less complex systems often question the usefulness of conducting social studies in their relatively simple production processes. Based on the findings of the First Workshop on the Application of Social Research: Seeking a Methodology (Ruiz 1994) and the Second Workshop on Methodological Aspects of Social Analysis in Farming Systems Research (of which this publication is the result), certain principles stand out for orienting the degree and intensity of participation of the social sciences in the various stages of the systems research approach. These principles include:

- The more complex the production systems and the lower the socioeconomic level of the producers involved, the more intensive and comprehensive are the social analyses required.

- The higher the level of household consumption and off-farm activities within the campesino family's economy, the more in-depth the economic and socioanthropological studies should be.

- Poorer ecological environments require more in-depth socioeconomic analysis.

- In systems (1) whose final products are market-oriented, (2) that are located in adequate agroecological environments, and (3) whose socioeconomic levels--though typical of small-scale producers--are not extreme, the participation of the social sciences within the systems approach need not be so extensive nor in-depth.

Based on the above, it is possible to define the terms of reference and the nature of the participation of economic and sociocultural studies in the different phases of the systems approach, not forgetting that physical and biological studies are completely separate issues.

In projects where the social sciences should play a key role, the next step is to decide at which phase of the systems approach these disciplines should intervene, and what type of data are needed in order to provide a sound basis for technology generation and transfer.

As explained in previous chapters, the three areas of work described (social psychology, social anthropology and economics) can provide solutions, at various levels, to the production or technology adoption problems faced by small farmers.

Social psychology enables researchers to analyze and interpret the often subconscious substrata and life strategies of the target population. These include aspirations, production orientations, attitudes to change, and the producers' ultimate objectives for their agricultural activities.

Socioanthropological and cultural analyses allow researchers to define producers' life strategies, their so-called "cosmic vision," their insertion into their social and economic environment--both immediate (a village community) and larger-context (micro-region, province or state). With this type of analysis, it is possible to define the different interrelationships between the producer's economic activities, the components of the decision-making processes involved in production, and the long-term vision that comes with the need for "family reproduction."

Also identified (see chapter by Claverías) are the short-term strategies generated by the "reincidence" of production, a factor not taken into consideration by some researchers from the biological sciences, who regard each farming year as a separate element. The reincidence of production determines and connects production resources over successive cycles, resources at times linked to recurring production systems, and to the household's own needs in terms of consumption as well as seeds and economic resources to start a new farming cycle. One production strategy that occurs within this framework is seasonal migration, which injects new economic resources for continuing or initiating agricultural activities and investment.

The collective subconscious and the household production and reproduction strategies are responsible for the economic dynamics of small-scale production systems. Economic analyses therefore contribute an additional variable: time. The linkage between production cycles and long-term strategies creates a time-dependent framework for economic activities, investment decisions and the orientation of the agricultural production system as managed by the farmer. Nevertheless, economists must take as their starting point the entire range of psychosocial and anthropological findings, and must adapt analytical and measuring instruments to these characteristics if they are to correctly assess farmers' economic goals.

It should be stressed that the technology employed by producers and the characteristics of their agricultural management and investment are ultimately the product of the psychosocial, cultural, anthropological and economic processes at work. The attempt to transform small-scale agricultural production on the strength of technical interventions alone is only possible in the case of market-oriented farms where the producers have already successfully completed the first stage of their insertion into regional economies. The smaller in scale and the more limited the producer's socioeconomic situation, the more important it is to understand and explore the intricacies of survival and production strategies. Only then will it be possible to execute successful technology transfer programs (Zandstra 1982; Rhoades 1983b).

At what point should the social sciences be incorporated into the systems research approach? Perhaps the most important period is during the diagnosis and characterization of the production systems concerned. The detailed description of components, interactions, production processes and yields should include both life and production strategies, socioeconomic levels, producer typology, and household reproduction and production strategies.

In other words, it is during the first stage, when researchers set out to describe the systems and gain an understanding of their *modus operandi*, that elements should be fleshed out explaining the farmer's vision of his/her own production system.

At later stages, depending on the nature and complexity of the projects or programs, there may be a need for in-depth diagnostic studies of some of the social variables described here and also by Quijandría et al. (1990).

Finally, the conclusions of social science analyses are particularly useful at the stages of technology transfer, organization and training of small farmers. An understanding of the ecological and regional socioeconomic environment and the producer's aspirations will enable researchers to generate appropriate technologies and transfer methods tailored to the sociocultural environment of the target population.

In this book, various techniques associated with social science research have been selected and directly linked to production phenomena and processes that, if correctly applied, will ensure the ultimate success of research, technology transfer and rural development programs. In short, these techniques will bring about a significant change in the income and standard of living of the target population.

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ANNEXES

ANNEX I

LIST OF PARTICIPANTS ATTENDING THE SECOND WORKSHOP ON "METHODOLOGICAL ASPECTS OF SOCIAL ANALYSIS IN FARMING SYSTEMS RESEARCH"

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ANNEX 2

METHODOLOGY FOR THE ANALYSIS OF PSYCHOSOCIAL PHENOMENA

Ana María Montero

Methodology for the psychosocial analysis of production: Inventory of basic life objectives

I. General data

Code ____
Sex _____
Marital status ______
Number of children ____
Age ____
Date of birth __/__/__
Place of birth ____________
Country _______
Region ________
Length of residence in region ___ years ___ months
Occupation ___________________
Activity in which the individual engages _______________________
Do you have people working under you? Yes __ No __
Production system in which you work ________________________
Date questionnaire completed __/__/__

II. Instructions

This questionnaire contains 40 statements referring to objectives that can be attained in life. For each objective, choose from the five possible levels the one that most closely reflects your own opinions and feelings, marking it with an X.

E - an essential objective is one that is absolutely necessary for enjoying a good life.

I - an important objective is one that you consider useful but not absolutely essential in order to live.

D - a desirable objective is one that would be gratifying, but is not important to enjoy a good life.

N - an objective that does not interest you is one that holds no meaning for you, however you look at it.

R - a rejected objective is one that you neither desire nor need.

Remember to answer each of the statements by marking with an X the letter that most closely reflects your own opinion regarding these life objectives. Work alone, do not discuss your answers with anyone else. Please answer all the statements as quickly and as spontaneously as possible.

EXAMPLE	E	I	D	N	R
1. To have a job	X				
2. To attend festivities			X		
3. To get my own way					X

III. Inventory of basic life objectives

Code ____ Region ________ Sex ____ Date __/__/__
Age ___ Grade completed at school __________

Levels of objectives:

E=ESSENTIAL D=DESIRABLE R=REJECTED I=IMPORTANT N=OF NO INTEREST

1 To accept limitations and be cautious
2 To ensure means of survival
3 To accept laws and other regulations
4 To participate in agricultural technological development
5 To oversee growth and development of children under 3 years
6 To get married
7 To have access to minimum services (water and drains)
8 To consume wholesome foods
9 To give and receive wholesome foods
10 To give and receive love
11 To develop own capabilities, to attempt new things in the farming system
12 To decide exactly what I wish to obtain from production
13 To do something important in life
14 To defend honesty and justice
15 To devote myself to causes or ideals
16 To prevent another person from being hurt
17 To be organized and/or belong to an organization
18 To strive to realize all my ideals
19 To assess my successes and failures
20 Not to make mistakes
21 To take care of myself and others
22 To get a minimum number of hours of sleep
23 To belong to groups (family, friends and organizations)
24 To respect and take care of my parents
25 To submit myself to the collective wishes of everyone else
26 To be sensitive to the needs of others
27 To be honest with myself and others
28 To be regarded and recognized for my services
29 To have critical judgment
30 To have decision-making power over the control of the production system

31 To be successful and achieve concrete rewards
32 To use my abilities to solve my problems
33 To enjoy physical, mental and social well-being
34 To be able to deal with preventable causes of illness
35 To have a healthy and balanced diet
36 To have children
37 To satisfy any desire or impulse
38 To enjoy sexual satisfaction
39 To enjoy a comfortable, problem-free life
40 To value the fruits of my life

IV. KEY TO SCORING AND TABULATION SHEET

SATISFACTION OF ESSENTIAL NEEDS		SATISFACTION OF SECONDARY OR SOCIAL NEEDS		SATISFACTION OF NEED FOR CAUTIOUSNESS, SOCIAL ORGANIZATION, AVOIDANCE OF HARDSHIP	
Element	Value	Element	Value	Element	Value
05		06		01	
07		10		02	
08		21		03	
09		23		16	
22		24		17	
33		36		20	
34		37		25	
35		38		39	
TOTAL		TOTAL		TOTAL	

SATISFACTION OF NEED FOR DEVELOPMENT, CREATIVE, PERSONAL AND ORGANIZATIONAL EXPANSION		MAINTENANCE OF AN INTERNAL-EXTERNAL ORDER, SCALE OF SOCIAL, MORAL, SUCCESS AND DEVELOPMENT VALUES	
Element	Value	Element	Value
11		04	
12		13	
18		14	
26		15	
27		19	
28		29	
30		31	
32		34	
TOTAL		TOTAL	

Table 1. Summary of average scores obtained in the vital objectives questionnaire by guinea pig agricultural producers

Levels of basic life objectives	**Aggregate scores:**	**0-39**	**41-79**	**80-119**	**120-159**	**180-200**
	Percentile:	10%	25%	50%	75%	90%
Essential	I					
Important	II					
Desirable	III					
Necessary	IV					
Rejected	V					

Table 2. Summary of average scores obtained in the vital objectives questionnaire by areas of guinea pig-agricultural producers

Areas of basic life objectives	Aggregate scores:	0-7	8-15	16-23	24-31	30-40
	Percentile:	10%	25%	50%	75%	90%
Essential needs	I					
Secondary-social needs	II					
Need for caution, social organiz., submission and avoidance of hardship	III					
Need for development and creative expansion	IV					
Maintenance of internal and external order; scale of values	V					

ANNEX 3

METHODOLOGICAL ASPECTS OF ECONOMIC ANALYSIS

Víctor Agreda

Table 1. Agricultural component: Labor, inputs and production

No. of survey:____________
Crop 1:_____________
Surface area, ha

COSTS

SYSTEM INFLOWS					UNITS PER MONTH					
	Jan	Feb	Mar	...	Oct	Nov	Dec	Total	Annua l Cost	Unitl ntis
PERSON-DAYS										
Soil preparation									0.00	
Plowing									0.00	
Planting									0.00	
Fertilizer application									0.00	
Cleaning/ridging									0.00	
Phytosanitary treatment									0.00	
Other work									0.00	
Harvesting									0.00	
Threshing/ shelling									0.00	
Storing									0.00	
TOTAL PERSON-DAYS	0	0	0	0	0	0	0	0	0.00	
INPUTS										
Seed, kg.									0.00	
Manure, kg.									0.00	
Chemical fertilizer, units									0.00	
....									0.00	
....									0.00	
....									0.00	
....									0.00	
Phytosanitary treatment									0.00	
....									0.00	
....									0.00	
....									0.00	
OTHER INPUTS										
Oxen hours									0.00	
Tractor hours									0.00	

HARVESTED PRODUCTION			UNITS PER MONTH						
	JAN	FEB	MAR	....	OCT	NOV	DEC	ANNUAL TOTAL	PRICE Intis
First harvest								0.00	
Second harvest								0.00	
TOTAL								0.00	
OUTFLOWS								0.00	
Residues/hay, kg								0.00	
Household								0.00	
Consumption, kg								0.00	
Sales, kg								0.00	

Table 2. Livestock component: Labor and inputs, evolution and outputs

No. of survey:_______________

Beef cattle:_______________

SYSTEM INPUTS			UNITS PER MONTH						
	Jan	Feb	Mar	...	Oct	Nov	Dec	Annual Total	Unit Intis
PERSON-DAYS									
Pastures								0.00	
Management								0.00	
Animal health treatment								0.00	
Supplementary feeding								0.00	
Milking								0.00	
Cleaning of cattle pens								0.00	
Other work								0.00	
								0.00	
TOTAL PERSON-DAYS	0	0	0	0	0	0	0	0.00	0.00
INPUTS								0.00	
Residues/hay, kg								0.00	
Veterinary products								0.00	
....								0.00	
....								0.00	
....								0.00	
Feed supplements								0.00	
....								0.00	
....								0.00	
....								0.00	

EVOLUTION OF THE HERD										
	Jan	Feb	Mar	...	Oct	Nov	Dec	Total	Annual Price	Unit Intis
Bulls									0.00	
Oxen									0.00	
Cows									0.00	
Heifers									0.00	
Bull calves									0.00	
Unweaned heifers									0.00	
Unweaned bull calves									0.00	
Newborns									0.00	

SYSTEM OUTFLOWS										
	Jan	Feb	Mar	...	Oct	Nov	Dec	Total	Cost/ year	Unit Intis
SALES										
Milk, l									0.00	
Animals on the hoof									0.00	
Manure, kg									0.00	
Oxen, days									0.00	
HOUSEHOLD CONSUMPTION										
Milk, l									0.00	
Animals on the hoof									0.00	
Manure, kg									0.00	
Oxen, days									0.00	

Table 3. Analysis of annual flows of labor under the livestock component

	Jan	Feb	Mar	...	Oct	Nov	Dec	Total	Cost/ year	Unit Intis
LABOR										
Beef cattle									0.00	
Swine and others									0.00	
Total person-days per month	0	0	0	0	0	0	0	0	0.00	0.00
Family labor available, person-days									0.00	
Surplus/Deficit Person-days	0	0	0	0	0	0	0	0	0.00	0.00

Table 4. Analysis of livestock cash flow

	Jan	Feb	Mar	...	Oct	Nov	Dec	Total	Cost/ year	Unit Intis
CASH INCOME (SALES)	0	0	0	0	0	0	0	0	0.00	0.00
Beef cattle	0	0	0	0	0	0	0	0	0.00	0.00
Swine and others	0	0	0	0	0	0	0	0	0.00	0.00
CASH EXPENSES	0	0	0	0	0	0	0	0	0.00	0.00
LABOR HIRED (DEFICIT)	0	0	0	0	0	0	0	0	0.00	0.00
Beef cattle	0	0	0	0	0	0	0	0	0.00	0.00
Swine and others	0	0	0	0	0	0	0	0	0.00	0.00
INPUTS AND OTHER INFLOWS	0	0	0	0	0	0	0	0	0.00	0.00
Beef cattle	0	0	0	0	0	0	0	0	0.00	0.00
Swine and others	0	0	0	0	0	0	0	0	0.00	0.00
MONTHLY BALANCE	0	0	0	0	0	0	0	0	0.00	0.00
ACCRUED BALANCE	0	0	0	0	0	0	0	0	0.00	0.00

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The Latin American Research Network for Animal Production Systems (RISPAL) was established in 1986 in order to promote, among projects and institutions affiliated with the network, the exchange of technology and the development of research methods for animal production systems. It operates under an agreement between the International Development Research Centre (IDRC) and the Inter-American Institute for Cooperation on Agriculture (IICA). In 1986, a renewal of the IDRC-IICA agreement assigned RISPAL responsibilities for the Central American and Caribbean regions, emphasizing the promotion of research, training and information services as ways to strengthen national and regional institutions involved in sustainable animal production. As such, RISPAL will promote, facilitate, and coordinate activities related to sustainable animal production.

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